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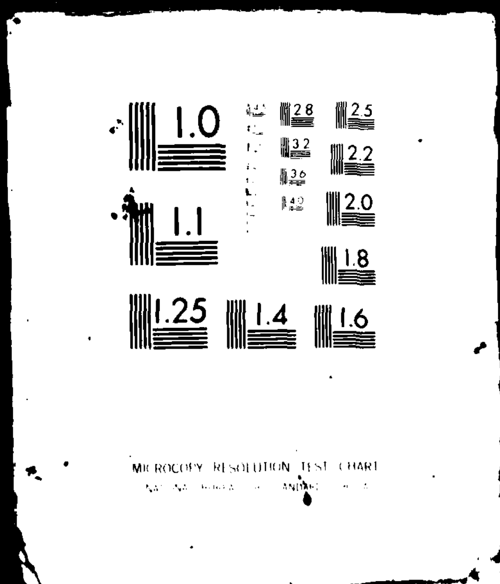

NOVEMBER
1981

FEASIBILITY STUDY OF SHORELINE PROTECTION AND LAKE LEVEL REGULATION FOR

RECONNAISSANCE REPORT

VOLUME 2 - APPENDICES

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report identifies problems and needs along the United States shoreline of Lake Ontario associated with shore erosion and coastal flooding. The report includes a survey of existing conditions including those associated with the natural and human environment. Alternatives are formulated to address the needs and include lake level vegetation and standard structural and nonstructural shoreline protection measures. Significant flood and erosion areas are identified based on dollar damages and the feasibility of protection considered based

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on the costs of protection. Several areas were identified where shoreline protection may be feasible.

APPENDIX A

TECHNICAL REPORT

LAKE ONTARIO SHORELINE PROTECTION STUDY

APPENDIX A

TECHNICAL REPORT

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SECTION 1

INTRODUCTION

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SECTION 1 - INTRODUCTION

From the time man first appeared on this earth, he has been attracted by the sea. It has provided him nourishment, pleasure, and transportation. Civilizations have developed and been shaped by this association with the sea. Today, more than ever, life within the coastal zone, both human and nonhuman, continues to be influenced by its relationship with the sea. This is especially evident on the Great Lakes where early settlement focused on the water transportation route of a growing nation. Outposts and forts along the lakes developed into major cities as trade flourished on the lakes. As the economic vitality of the region grew, so did the number of people. This, of course, resulted in further development, to which the coastal zone was no exception.

In conjunction with a growing America and the Great Lakes region, man has made many technological advancements, one of which has been his ability to harness great rivers in his quest for electrical power and expansion of waterborne commerce. This is especially evident on the St. Lawrence River where, since 1700, improvements have been made to provide a navigation route to the nation's heartland. In 1959, the present St. Lawrence Seaway opened the Great Lakes to the deep-draft vessels of the world making the Great Lakes the nation's "fourth seacoast." It also provided a means of harnessing the great power of the river itself for electricity. The creation of the dams necessary for the navigation and hydropower, in turn, gave man control over another aspect of nature, that being the amount and timing of the outflows from Lake Ontario, providing partial control of lake levels by reducing the high levels and raising the low levels.

1.1 STUDY AUTHORITY

Since the construction of control works on the St. Lawrence River, the water level of Lake Ontario and its regulation have been a point of contention between the interests affected by such regulation, i.e., riparian, recreation, environmental, power, and navigation.

During the period 1972 through 1976, the Great Lakes basin experienced a period of abnormally high precipitation which resulted in high lake levels. The highest levels for Lake Ontario during this period were during 1973, which coupled with a major storm on 17-19 March 1973, inflicted most of the riparian damages sustained during this 4-year period. In addition to damages to shoreline property owners, there allegedly were undetermined amounts of damage to the natural environment. In the eyes of the riparian and environmental interests, those high lake levels and resulting damages were experienced to the benefit of power and navigation interests. They believed that their losses could have been minimized via lake level regulation. Thus,

the present plan of regulation, Plan 1958-D, came under renewed scrutiny. This provided the impetus for authorization of this study.

On 10 June 1976, Senator James L. Buckley introduced a bill in the Senate of the United States (S.3548), which was subsequently enacted into law as Section 180 of the Water Resources Development Act of 1976 (P.L. 94-587) and reads as follows:

> "(a) The Secretary of the Army, acting through the Chief of Engineers, is directed to develop a plan for shoreline protection and beach erosion control along Lake Ontario, and report on such plan to the Congress as soon as practicable. Such report shall include recommendations on measures of protection and proposals for equitable cost-sharing, together with recommendations for regulating the level of Lake Ontario to assure maximum protection of the natural environment and to hold shoreline damage to a minimum.
>
> (b) Until the Congress receives and acts upon the report required under subsection (a) of this section all Federal agencies having responsibilities affecting the level of Lake Ontario shall, consistent with existing authority, make every effort to discharge such responsibilities in a manner so as to minimize damage and erosion to the shoreline of Lake Ontario.
>
> (c) There is authorized to be appropriated to carry out this section, $2,000,000.
>
> (d) This section may be cited as the 'Lake Ontario Protection Act of 1976.'"

The study was assigned by the Office of the Chief of Engineers, U. S. Army Corps of Engineers to the North Central Division. In turn, it was assigned to the District Engineer, Buffalo District. The study has been entitled the Lake Ontario Shoreline Protection Study.

The study authority is interpreted as directing the Corps to develop and report on a plan for shoreline protection and beach erosion control for the U. S. shoreline of Lake Ontario. The report will specifically address the following:

- recommendations on measures of shoreline protection;

- proposals for equitable cost-sharing; and

- recommendations for regulating the level of Lake Ontario to assure maximum protection of the natural environment and to hold shoreline damage to a minimum.

Recommendations on measures is interpreted to mean a feasibility investigation of all measures which would effectuate protection to the U. S. shoreline to include structural and nonstructural measures. This interpretation

is in keeping with Principles and Standards for Planning Water and Related Land Resources, promulgated by the Water Resources Commission and applicable to all Federal, Level C studies, such as this, and the policy of the Chief of Engineers.

The authorization specifies both beach erosion control and shoreline protection. In full consideration of testimony given to the Subcommittee on Water Resources of the United States Senate relative to S.3548, beach erosion control and shoreline protection is interpreted to mean both public and private shoreline relative to erosion and flooding due to lake levels. This is a departure from the traditional role of the Federal Government, that being only beach erosion control of public lands or lands from which public benefit is derived. This interpretation conforms with Congress's second direction relative to cost-sharing recommendations. Because Congress addressed the issue of cost-sharing in its direction and specifically mentioned "equitable," it was mindful that Section 180 was addressing an area which was nontraditional and not covered by existing cost-sharing statutes, namely, the subject of erosion of private property.

1.2 SCOPE OF THE STUDY

The scope of the Lake Ontario Shoreline Protection Study is reflective of the study authority and the areas of investigation and possible impacts. The Water Resources Development Act of 1976 (P.L. 94-587, Section 180) directs that the study investigate shoreline protection problems of Lake Ontario. This direction was given unilaterally by the U. S. Congress and not bilaterally with Canada, therefore, the area of problem investigation is restricted to the U. S. shoreline of Lake Ontario. In consideration of possible alternative plans to be considered and resulting impacts, such as modifications to the St. Lawrence River, the study area is expanded to include all of Lake Ontario and the St. Lawrence River downstream to Montreal, Quebec. Those areas within Canada will be investigated from the standpoint of possible solutions, e.g., increased capacity of the St. Lawrence River, and impact assessment, and to the level of detail permitted by Canadian coordination (see Section 1.3). The study area is shown on Figure 1-1.

Focus of the study will be directed at the problems of the shoreline which relate to the study authority, namely, shoreline erosion and inundation. There are basically two aspects of shoreline problems. The first aspect is associated with the problems as they relate to existing development, i.e., existing damages to the shoreline and structures. The second aspect relates to the future nature of the problems, i.e., continued development in erosion and floodprone areas. To be responsive to Congressional direction and to truly provide a plan for shoreline protection, the study will address both of these aspects by providing recommendations relative to existing and future development.

Because the problems and needs associated with erosion and flooding of the shoreline provided the impetus to and the subject of the Congressional direction to develop a plan for protecting the shoreline, they will serve as the primary focus for formulating solutions or plans. Other water and related land resources problems and needs of the shoreline will be addressed

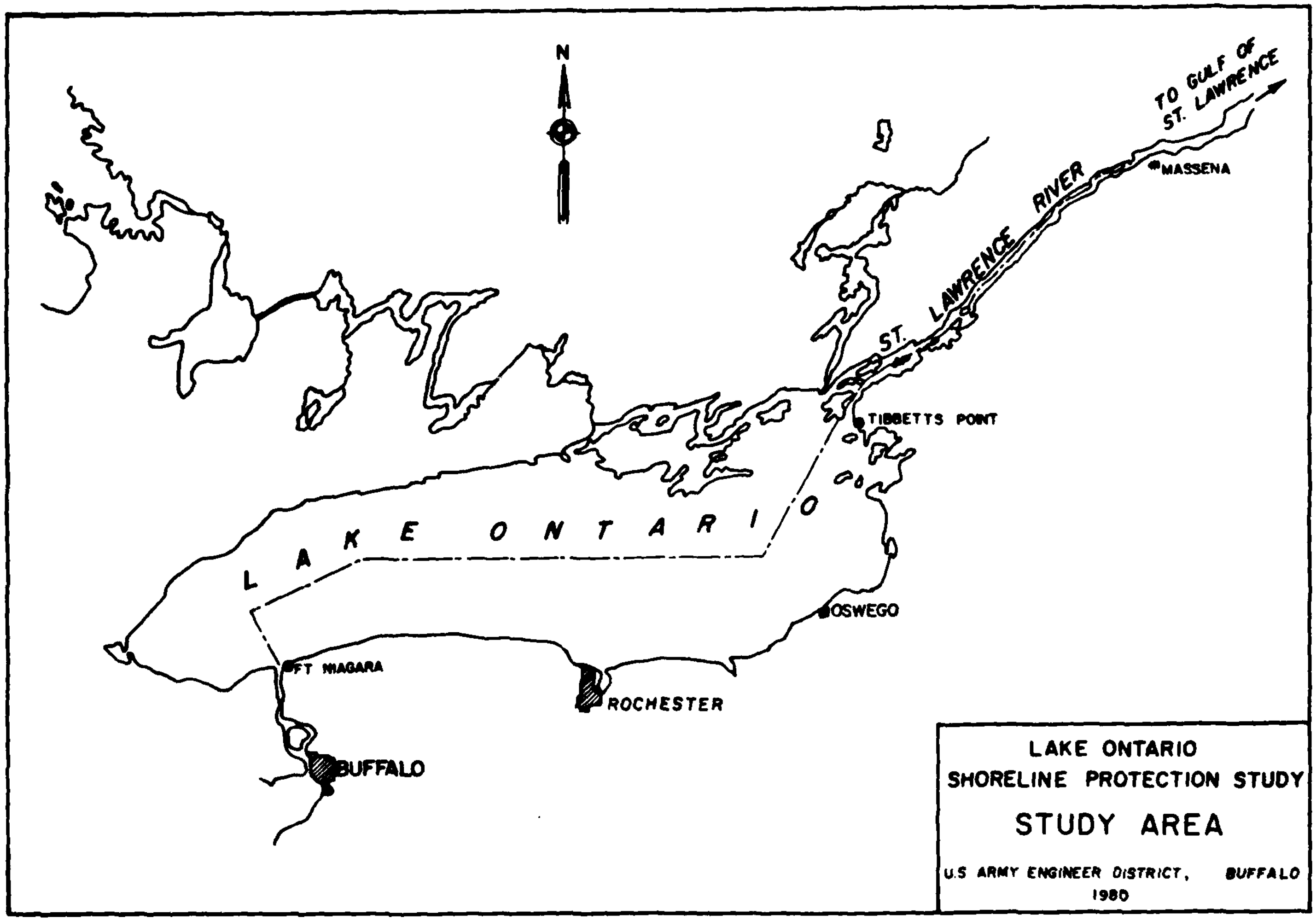
N
TO GULF OF ST. LAWRENCE
MASSENA
ST. LAWRENCE RIVER
TIBBETTS POINT
LAKE ONTARIO
OSWEGO
FT NIAGARA
ROCHESTER
BUFFALO
LAKE ONTARIO
SHORELINE PROTECTION STUDY
STUDY AREA
U.S ARMY ENGINEER DISTRICT, BUFFALO
1980

Figure 1.1

on a secondary basis. That is to say, their solutions will be addressed in conjunction with or as a consequence of solutions for shoreline erosion and flooding. An example of this would be an area which is experiencing very high development pressures where a solution addressing the future aspect of the problem might be purchase of land, either outright or easement. This solution, while directed toward erosion and flooding, would also address the need for public access. It is within this primary/secondary relationship that plans will be formulated.

The study and the scope and breadth of its investigation will be conducted with full consideration of the limitations on implementation of various measures. Detail will be given to those alternative plans which can be authorized as a direct result of this study. Those plans, such as associated with lake level and land use regulation and/or requiring further study by an implementing authority, will receive a lesser degree of detail. This is not to say that they will receive lesser attention when developing alternative plans. In consideration of the number of possible alternatives and a limitation of study funds, those alternatives which can be directly implemented as a result of this study will receive the detail and analysis necessary for definitive selection and recommendation.

1.3 STUDY PARTICIPANTS AND COORDINATION

The U. S. Army Corps of Engineers has been directed by the U. S. Congress to make the investigation, and thus, has the responsibility for the conduct of the Lake Ontario Shoreline Protection Study. As the accountable official for its conduct, the District Engineer, Buffalo District, assumes full responsibility and control for the accomplishment of all aspects of the study including its conclusions and recommendations.

Stage 1 of the study was conducted utilizing an interdisciplinary team from the Buffalo District staff which included a study manager, a terrestrial ecologist, an aquatic biologist, a sociologist, an archeologist, an economist, a coastal geologist, and a hydraulic engineer. The efforts of Corps personnel were augmented by the services of two Contractors. Great Lakes Tomorrow, an international, nonprofit citizens organization, was contracted to conduct two series of workshops. A second Contractor, Great Lakes Laboratory of the State University College at Buffalo, was contracted to provide a research of the existing literature, to conduct a physical inventory of the U. S. shoreline of Lake Ontario, and to perform a cursory feasibility evaluation of structural shoreline protection.

United States Fish and Wildlife Service (USF&WS), with the cooperation of New York State Department of Environmental Conservation (NYSDEC) has furnished three Planning Aid letters (see Appendix D). These letters focused on a profile of existing fish and wildlife resources, identification of problems, needs, and opportunities associated with those resources, and an assessment of potential impacts of measures. Several meetings have been held with USF&WLS and NYSDEC to identify and scope studies for Stage 2 of the planning process. NYS Coastal Zone Management Program and the NYS office of Parks and Recreation have provided valuable input to the development of this report.

The study has been coordinated with the various international, Federal, State, regional, and local agencies, organizations, and general public. A letter of initiation was sent to the concerned political representatives, agencies, and organizations informing them of the study and its intent.

The amount of coordination with agencies during Stage 1 has been commensurate with the focus and detail of Stage 1. This coordination has essentially been conducted on an agency-by-agency basis and concentrating on compiling existing information.

More formal coordination has been accomplished beginning with a meeting of various agencies and interests which was held in Syracuse, NY, on 17 and 18 January 1980 at the request of NYSDEC to discuss the Lake Ontario Shoreline Protection Study and other studies and programs relative to Lake Ontario and the St. Lawrence River. Additionally, two coordination and advisory committees have been established. The first is the Interagency Coordination Committee which was established to coordinate the Lake Ontario Shoreline Protection Study and the St. Lawrence Seaway-Additional Locks Study with the member agencies, and to coordinate the programs of the member agencies. The following is a list of the agencies and their representatives on the Interagency Coordination Committee.

Federal

Environmental Protection Agency	Dr. Peter W. Anderson
St. Lawrence Seaway Development Corp.	David C. N. Robb
U. S. Army Corps of Engineers	Colonel George P. Johnson
U. S. Fish and Wildlife Service	William H. Gill
U. S. Geological Survey	William B. Gannon
U. S. Soil Conservation Service	Henry S. Stamatel

State of New York

Department of Agriculture and Markets	Robert J. Byrne
Department of Environmental Conservation	John A. Finck
Department of State (CZM)	Neil MacCormick
Department of Transportation	Gunnar Hall
Office of Parks and Recreation	Dr. Peter Buttner
Power Authority of the State of New York	John Bartholomew Bruce McClean
St. Lawrence-Eastern Ontario Commission	Daniel J. Palm
Sea Grant	Michael W. Duttweiler

Regional

Black River-St. Lawrence Regional Planning Board	Friedrich J. G. Aufschlager
Central New York Regional Planning and Development Board	Benjamin D. Manton, III
Erie & Niagara Counties Regional Planning Board	Thomas Dearing

Regional (Cont'd)

Genesee/Finger Lakes Regional Planning Council	(See Monroe County)
Great Lakes Basin Commission	Lee Botts

County

Jefferson County	Ralph W. Timerman
Monroe County	Don B. Martin
Niagara County	Glenn Mathiasen
Orleans County	Lyndon D. Billings
Oswego County	Alman Hawkins
St. Lawrence County	Mary Verlaque
St. Lawrence County Environmental Management Council	James Pritchett
Wayne County	Harold R. Halldow

The second group, Citizens Advisory Committee, was established to serve as an advisory committee and to serve as a sounding board of the views, preferences, issues, and priorities of the citizens along the Lake Ontario shoreline. Its members represent the riparian and recreational interests. Membership is made up of two members from each of the shoreline and St. Lawrence River counties, except for Cayuga County, which because of its comparatively short shoreline, has only one member. Each member is appointed to the Committee by the U. S. Congressional Representative for the particular county. In the case of Monroe County, the shoreline is split between two Congressional Districts. In this case, Congressmen Horton and Conable were requested to nominate one member each for Monroe County. The following is a listing of the membership of the Citizens Advisory Committee and the county which he/she represents.

Niagara County

Mrs. Josephine Beilein
Mr. Walter E. Moxham, Jr.

Monroe County

Mr. Donald J. Riley
Mr. Thomas H. Gosnell

Cayuga County

Honorable Ormond Gale

Jefferson County

Mr. Byron W. Parsons, DVM
Mr. John R. Walker

Orleans County

Mr. Richard G. Hoffman
Mrs. Carol Oschmann

Wayne County

Mr. Donald F. Ketchum
Mr. John Love

Oswego County

Mr. Robert F. LaPoint
Mr. Charles Russell

St. Lawrence County

Mr. George E. Dillingham
Mr. Robert A. LaClair

Initial meetings of these two committees were held on 16 and 17 May 1980, respectively, in Syracuse, NY.

In consideration of the unilateral direction or authorization of the study and diplomatic protocol, coordination of the study with Canada and the International Joint Commission has been restricted to the Buffalo District's activities relative to the International Joint Commission's International Lake Erie Regulation Study and the International St. Lawrence River Board of Control. Information brochures developed for the public involvement workshops of 23-27 June 1980 have been furnished to the U. S. and Canadian members of the International St. Lawrence River Board of Control and its Working Committee to inform them of and provide the status for the study. A draft letter to the Department of State providing an update on the study has been transmitted to the Office of the Chief of Engineers for their consideration.

1.4 OTHER RELATED STUDIES

Being the largest freshwater resource in the world, the Great Lakes have received considerable study over the years. This is especially evident in recent years with the development of programs which focus on the societal/water resource interface or interrelationship. Programs such as erosion control have developed as a result of the resource's impact upon man and his desire for development. Other programs, such as the Coastal Zone Management Program, strive to understand man's impact on the resource and to manage his development to provide a mutually acceptable relationship in the future. Of the many programs which have or are addressing the Great Lakes, there are a few which are specifically related to the Lake Ontario Shoreline Protection Study either directly or indirectly. The following presents a description of these programs, both Corps and of other agencies.

1.4.1 U. S. ARMY CORPS OF ENGINEERS PROGRAMS

a. Big Sandy Creek - Mexico Bay, NY (Little Salmon River).

This study was authorized by Resolution of the Committee on Public Works of the House of Representatives, dated 31 July 1957. This study is a feasibility investigation focusing on the need for a recreational small-boat harbor on Lake Ontario at the mouth of the Little Salmon River. A Preliminary Feasibility Report was prepared in December 1978, presenting an initial look at alternative plans and recommending three of the alternative plans be considered in detail during the last stage of the study. All three plans require channel modifications and shore structures at the mouth of the Little Salmon River. Presently, the study is awaiting funding to initiate the third and final stage of the study.

b. Great Lakes-St. Lawrence Seaway Navigation Season Extension Program.

This program was authorized by Section 107 of the River and Harbor Act of 1970 (P.L. 91-611). The purpose of the study is to determine the feasibility of extending the navigation season on the Great Lakes and St. Lawrence Seaway System, to determine the extent of Federal participation, if any, and to make a recommendation to the U. S. Congress based on these findings. The overall program was divided into two basic aspects. The first was

the Demonstration Program which was to determine the practicability of extending the navigation season. This program provided a significant amount of technical knowledge and operational experience based on actual 1971-1979 winter field experience. The Demonstration Program was completed in September 1979, concluding that winter ice navigation was practical from an engineering and operations standpoint. The second aspect of the overall program was the Feasibility Study which was aimed at determining whether some extension of the navigation season has engineering, economic, social, and environmental feasibility, and if so, to identify potential actions that hold the most promise for successful operation.

The final report to Congress, Final Survey Report and Environmental Impact Statement, were completed December 1979. The report concluded "that in view of the diversity of opinion regarding any significant extension of the navigation season and the substantial expenditures ultimately required by all entities to make ice navigation safe and efficient, it is advantageous to advance incrementally toward the longest feasible navigation season. Navigation season extension is considered engineeringly and economically feasible on the upper three Great Lakes, the St. Clair River-Lake St.Clair-Detroit River System and Lake Erie, from the present season to a 12-month season, and on Lake Ontario and the International Section of the St. Lawrence River from the present season to a 10-month season. To assure environmental and social feasibility of this program, an Environmental Plan of Action would be accomplished concurrently with implementation and execution of post-authorization planning, engineering, construction, and operations. This would involve a program of baseline data collection and assessment prior to construction and includes monitoring during construction and operations to identify needed changes or adjustments in policy and management actions. Additionally, a validation process is incorporated in the Plan of Action to confirm continuation of the project."

The 10-month season for the St. Lawrence Seaway is essentially a 1-1/2 month extension to the present navigation season. Structural modifications will include the placement of additional ice booms in the river which will assist in stabilizing an ice cover. An early and stable ice cover will affect the flow regime of the river, which may reduce the length of time during which flows must presently be reduced to form such an ice cover. This, of course, will have a direct impact on alternatives for lake level regulation being addressed by this study.

c. Great Lakes Shoreland Damage Study.

The people of the Great Lakes States, through their representatives on the Federal Regional Council/Great Lakes Basin Commission Joint Task Force on Reduction of Shoreland Damages, requested the Corps of Engineers to conduct a study on the property and shoreland damages caused by high water levels on the Great Lakes during the 1970's.

The objectives of the Great Lakes Shoreland Damage Study were to:

(1) Develop flood and erosion damage estimates, using a study method acceptable to the States.

(2) Provide a base of information to evaluate the economic justification of damage reduction options.

(3) Institute a working relationship between the States and Federal agencies to aid the eventual implementation of damage reduction measures.

A pilot study of damages in 11 Great Lakes counties for the high water period, 1972-197[illegible], was completed in 1975; the survey of the remaining Great Lakes shoreline extended from 1976 to 1978. The purpose of the pilot program was to develop a reliable and inexpensive reconnaissance data collection method and to gather the damage data for the 11 counties. The pilot program helped demonstrate how to streamline some of the data collection methods and pointed out ways to substitute for or eliminate other activities. In addition, certain changes in survey methods were dictated by the Office of Management and Budget (OMB).

This report presents an estimate of the gross amount of damages incurred over the study period. Additional economic and hydrologic studies are now underway to estimate the average annual damages which can be attributed to long-term average changes in lake levels. This information will enable planners and the public to more fully understand the economic consequences of choices among alternative lake level regulation plans.

d. National Shoreline Study.

In the River and Harbor Act of 1968 (P.L. 90-483), the Congress gave to the Chief of Engineers special responsibilities for appraising, investigating, and studying the condition of the nation's shorelines and for developing suitable means for protecting, restoring, and managing them so as to minimize erosion induced damages. Other reports - 11 in number - primarily addressed to local and State authorities, complete the National Shoreline Study and provide the base from which this report is drawn. The reports provide guidelines and broad conceptual plans, but are not intended to produce project authorizations.

The National Shoreline Study, which was completed in 1973, finds 20,500 miles of the ocean and Great Lakes shores of the United States, Puerto Rico, and the Virgin Islands undergoing significant erosion. The study further finds that action to halt significant erosion appears justified along 2,700 miles of shore. The cost of constructing suitable protective works for these shores is estimated to be $1.8 billion (1970 price levels). The study suggests that priority attention should be given to 190 miles of shores where continued erosion is most likely to endanger life and public safety within the next 5 years. The cost of constructing protective works along these shores is estimated to be $240 million. About two-thirds of the areas where erosion is a serious problem are privately owned and not eligible for Federal assistance under present law. The study also finds that management to minimize adverse effects of erosion appears appropriate for 17,800 miles of shores undergoing significant erosion where action to halt the erosion may not be justified.

e. Olcott Harbor, NY.

This study was conducted in response to a 19 October 1967 Resolution by the Committee on Public Works of the House of Representatives. The study investigated the feasibility of further Federal improvement of the small-boat harbor at the mouth of Eighteenmile Creek and adjacent areas at Olcott, NY. The study was completed in November 1978 and is presently undergoing Washington level review prior to submittal to the Congress. The study determined that modification of the existing Federal project is warranted to effectively serve small craft navigation. Proposed modification would include an upstream extension of the Federal channel, construction of a detached west breakwater, a jetty, and an east breakwater, dredging of access and entrance channels, and provision of recreational fishing facilities, including a footbridge to the east breakwater.

f. Port Ontario Harbor, NY.

This project was authorized to be constructed under provisions of Section 2 of the River and Harbor Act (P.L. 14, 79th Congress, 1st Session), approved 2 March 1945, in accordance with plans and conditions set forth in House Document 446, 78th Congress, 2nd Session. The project was never constructed and subsequently deferred until funds were appropriated during FY 1976 for restudy. The Phase I General Design Memorandum, dated November 1978, reported the results of the restudy, recommending construction of a harbor-of-refuge for light-draft vessels at Port Ontario, NY. The plan of improvement consists of two shore-connected breakwaters, entrance and river channels, a sand bypass system, and a public wharf. The project is presently in the final design stage prior to construction, with completion of plans and specifications scheduled for completion by September 1980.

g. St. Lawrence Seaway-Additional Locks Study.

Authorized by Resolution of the Senate Committee on Public Works 15 June 1966, this study is to determine the adequacy of the existing locks and channels in the U. S. section of the Seaway in light of present and future needs, and the advisability of their rehabilitation, enlargement, or augmentation. The study is presently in the second stage of study development which will focus on developing alternative plans. Alternative plans will address modifications to the existing locks and channels in length, width, and depth, increasing the capacity of the existing system with additional locks of the same or larger size, along with accompanying channel modifications, all-weather navigation utilizing navigation aids insuring safe navigation during periods of fog, alternate trade routes such as the barge canal, using marine shunters or tugs to facilitate lock operations by decreasing lockage time, and alterations to channels to alleviate navigational maneuvering and control problems due to excessive currents. The study is scheduled for completion in May 1984. Alternatives for channel modifications will be coordinated with those of the Lake Ontario Shoreline Protection Study so that recommendations for each study are comprehensive and systematic in nature.

1.4.2 PROGRAMS OF OTHER AGENCIES

a. Great Lakes Basin Framework Study.

The Great Lakes Basin Framework Study was begun in 1967 to develop an information base and to prepare components for a future comprehensive, coordinated, joint plan.

The Framework Study Report, 25 appendix volumes, and an environmental impact statement, present a portion of the Great Lakes Basin Commission's work toward guiding conservation, use, and development of water and land resources in the Great Lakes area through the year 2020.

Based on available information, the volumes of the Framework Study contain descriptive materials, both tabular and textual, on what the problems are, what solutions should be explored, and what kinds of development the residents of the Great Lakes area prefer. These volumes identify and rank the sections of the Basin that have special problems requiring closer scrutiny both now and in the future. In addition, they give the estimated costs of dealing with resource problems and recommended courses of action that should be taken to ensure wise use of the resources.

b. Great Lakes Basin Plan.

The overall goal of the Great Lakes Basin Commission is to maintain and/or enhance the physical and social environment of the U. S. Great Lakes Basin consistent with the physical and social needs of the Basin's citizens. The primary means of accomplishing the Commission's goals and objectives is through the continuing development of the Great Lakes Basin Plan (comprehensive coordinated joint plan). The Great Lakes Basin Plan is intended to insure coordination and integration of the plans of private interests, local government, State government, Federal agency, and nongovernmental entities in the U. S. Great Lakes Basin. The Plan will require integration of programs associated with water quality, water supply, flood damage reduction, wildlife management, and other relevant water and related land resources programs, as well as institutional and policy coordination, at all governmental and private levels. The major characteristics of the Great Lakes Basin Plan are:

(1) The GLBP is dynamic and will be part of a continuous planning process.

(2) The development of the GLBP will assist in setting priorities, encouraging funding, and developing a sense of timing in terms of planning coordination.

(3) The GLBP will provide the means to assess cumulative program effects not readily apparent on a project-by-project basis.

(4) The GLBP will provide a means to express the viewpoints of the Great Lakes Basin region on a national scale.

(5) The GLBP will provide the opportunity for public participation throughout the planning process.

The first stage of the Great Lakes Basin Plan, completed in 1976, was the recommendations of the Great Lakes Basin Framework Study. This second stage will examine problems and issues in greater detail and will result in specific recommendations to solve them.

c. International Great Lakes Diversions and Consumptive Uses Study.

Under the Reference of 21 February 1977, the International Joint Commission established on 3 May 1977, the International Great Lakes Diversions and Consumptive Uses Study Board to examine and report upon the effects of existing and proposed diversions within, into, or out of the Great Lakes Basin, and the effects of existing and reasonably foreseeable patterns of consumptive uses on Great Lakes water levels and flows. The Board has established a Working Committee with three subcommittees: one to deal with diversions, one with consumptive uses, and the other with environmental assessments. Estimates of consumptive uses have been made and data sources, assumptions, and methodologies used to develop the withdrawals and consumptive use totals have been documented. Projection methodologies used by both the Canadian and U. S. sections were found to be mutually acceptable. Consumptive use totals have been tabulated for each lake by 5-year increments from 1975 to 2035 A.D.

Preliminary plans for proposed operation of the Long Lake-Ogoki Diversions, the Lake Michigan Diversion at Chicago, a combination of the Long Lake-Ogoki Diversions and the Lake Michigan Diversion at Chicago, and also a combination of the Long Lake-Ogoki Diversions, the Lake Michigan Diversions at Chicago, and the Welland Canal, 43 in total, have been developed and are being analyzed. A study of bankfull conditions for the Lake Michigan Diversion at Chicago has been made. The Study Board is presently scheduled to report its findings to the International Joint Commission in the summer of 1981. The Board's report will identify one or more diversion management scenarios and outline the range of likely impacts on the major interests to be affected. Projections of consumptive uses on the Great Lakes to the year 2035, and the attendant impacts will also be presented.

d. International Lake Erie Regulation Study.

Under the Reference of 21 February 1977, the International Joint Commission established, on 7 June 1977, the International Lake Erie Regulation Study Board. The Board's primary purpose is to undertake this study, taking into account the applicable Orders of Approval of the Commission and the recommendations of the Canada-Quebec Study of flow regulation in the Montreal region. Basically, the Board was directed to study the possibilities for partial regulation of Lake Erie and to consider the need for remedial or compensating works, or nonstructural approaches to protect interests potentially adversely affected by such partial regulation, including downstream interests on Lake Ontario and the St. Lawrence River. Limited regulation of Lake Erie would change its outflow regime, thus affecting the flows into Lake Ontario and the timing of those flows.

The Study Board established a Working Committee to accomplish the study. Presently, several structural alternatives at Squaw Island, between the

Niagara River and the Black Rock Canal, and at the head of the Niagara River are being investigated to effectuate additional discharge capacity out of Lake Erie. These structures have capacities ranging from about 4,000 cubic feet per second (CFS) to 30,000 cfs. The study is scheduled to be completed in 1981.

e. New York State Coastal Zone Management Program.

The New York State Coastal Zone Management Program is a response to the Coastal Zone Management Act (P.L. 92-583). The basic purpose of the program is to protect, preserve, develop, and restore coastal land, water, and air resources so they may continue to fulfill man's present and future needs. It proposes to balance the needs for continued Statewide economic growth and the protection of coastal resources. The development of the CZM Program began in 1974 with the design to most effectively protect, manage, and develop the State's limited coastal resources. Based upon a series of goals and objectives developed from recommendations of various publics, agencies and organizations, initial efforts were directed at determining the need, desirability, and feasibility of coastal management approaches and techniques. Coastal zones were then established, inventories of coastal resources prepared, and concerns analyzed. Existing policies were identified and new policies proposed for addressing the issues of concern. Preliminary management techniques needed for implementation were identified. The Coastal Zone Management Act requires that a State have the authorities and organizational structure necessary to implement its program. Thus, the program identified and proposed additional authorities which were necessary to implement the program. A draft report was published in March 1979 and presently, legislation has been proposed to create the necessary authorities for implementation. Once legislation is enacted and draft regulations developed, a final report will be prepared for review and approval by Office of Coastal Zone Management, NOAA. If the management program satisfies all of the Federal requirements and is approved, the State is then eligible for annual grants to administer its program.

f. Pollution from Land Use Activities (PLUARG).

In November 1972, the International Joint Commission appointed an International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG), composed of nine Canadian and nine United States representatives, to conduct the study under the Great Lakes Water Quality Board.

The purpose of this study was:

(1) to determine and evaluate the causes, extent and locality of pollution from land use activities;

(2) to gain an understanding of the relative importance of various land uses in terms of their diffuse pollutant loads to the Great Lakes;

(3) to examine the effects of the diffuse pollutant loads on Great Lakes water quality; and

(4) to determine the most practicable remedial measures for decreasing the diffuse pollutant loads to an acceptable level and the estimated costs of these measures.

Detailed plans for this study were developed in early 1973, and assignments made to both Canadian and United States agencies and qualified individuals to commence studies on specific tasks and programs within the PLUARG study. The detailed plans were subsequently updated in 1976.

The final recommendations of the PLUARG study were concerned with the following: (a) development of management plans; (b) implementation of management plans; (c) review and evaluation of management plan implementation; and (d) the role of the public.

g. Regulation of Great Lakes Water Levels.

By terms of the Reference of 7 October 1964, the Governments of Canada and the United States requested the International Joint Commission "...to determine whether measures within the Great Lakes Basin can be taken in the public interest to regulate further the levels of the Great Lakes or any of them and their connecting waters so as to reduce the extremes of stage which have been experienced and...for the purpose of bringing about a more beneficial range of stage and improvement in: (a) domestic water supply and sanitation; (b) navigation; (c) water for power and industry; (d) flood control; (e) agriculture; (f) fish and wildlife; (g) recreation; and (h) other beneficial public purposes." The International Great Lakes Levels Board was established by the International Joint Commission on 2 December 1964 to initiate and direct the studies required to answer the Reference.

A summary of the conclusions of the studies is as follows:

(1) Small net benefits to the Great Lakes system would be achieved by a new regulation plan for Lake Superior which takes into consideration the levels of both Lake Superior and Lakes Michigan-Huron.

(2) Regulation of Lakes Michigan-Huron by the construction of works in the St. Clair and Detroit Rivers does not warrant any further consideration.

(3) Further study is needed of the alternatives for regulating Lake Erie and improving the regulation of Lake Ontario, taking into account the full range of supplies received to date.

(4) The hydrologic monitoring network of the Great Lakes Basin should be progressively improved.

(5) Appropriate authorities should act to institute land use zoning and structural setback requirements to reduce future shoreline damage.

h. Sea Grant Program.

Sea Grant is a cooperative Federal and State program, parented by the U. S. Department of Commerce through the National Oceanic and Atmospheric Administration (NOAA).

The New York Sea Grant Institute was established in 1971 as a consortium of the State University of New York and Cornell University to extend the National Sea Grant Program to New York State as a continuing activity. The objectives of the institute which pertain to both the Atlantic and Great Lakes coastal zones are: (1) to sponsor research directed to the wise and improved use of coastal resources, to assist in the development of more effective management programs and to improve the conservation of resources of coastal lands and waters; (2) to inform the general public and officials who can improve the use of coastal resources through the work of the Sea Grant Advisory Service Program; and (3) to train students and to offer short courses to marine industry operators, community leaders, and the public in a wide variety of pertinent coastal resource and management topics. Through these elements, the Sea Grant Institute is directed to service for the New York State community at all levels of government, to its marine industries, and to the needs and interests of the public.

The New York Sea Grant research on recession rates has proved to be invaluable to the Lake Ontario Shoreline Protection Study.

i. Studies to Improve the Regulation of Lake Ontario.

Subsequent to the completion in 1975 of studies to improve the regulation of Lake Ontario, the International Joint Commission, by letter of 18 October 1978, requested that the International St. Lawrence River Board of Control update those studies to include "...examination of the period from 1900 to the present for the alternative plans and for Plan 1958-D and a comparison of how each alternative plan meets the range of stage and criteria compared with Plan 1958-D. The Board's report should include as well, the relative costs and benefits of the alternatives..." The Board, in turn, assigned to its Working Committee the task of preparing the updated report.

The purpose of this report is to present an update of the 1975 studies to improve the regulation of Lake Ontario. Those studies and this update examine the effects of modification of the present regulation method to make it more responsive to extremes of supply, while taking into account the impacts on the various interests both upstream and downstream from the St. Lawrence project.

1.5 THE REPORT AND STUDY PROCESS

1.5.1 PROCESS

The Lake Ontario Shoreline Protection Study is being conducted in accordance with guidelines set forth by Principles and Standards for Planning Water and Related Land Resources as established by the Water Resources Council in 1973 and revised 14 December 1979. These Principles and Standards (P&S) require each Federal agency to develop a framework for the systematic preparation and evaluation of alternative ways of addressing problems, needs, concerns, and opportunities under equal objectives of National Economic Development (NED) and Environmental Quality (EQ). NED is achieved by increasing the value of the nation's output of goods and services and

improving economic efficiency. EQ, on the other hand, is achieved by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. Principles and Standards also require the measurement and assessment of impacts of a proposed action and their display or account in terms of contributions to National Economic Development (NED), Environmental Quality (EQ), Regional Development (RD), and Social Well-Being (SWB). The conditions and criteria which must be applied when evaluating plans are also set forth by P&S and other laws governing water resources development.

This study will utilize the multiobjective planning framework established by the Office of the Chief of Engineers, U. S. Army Corps of Engineers, and published in the Code of Federal Regulations, Title 33, Part 290. This framework, in the form of Corps regulations, sets forth guidance for conducting feasibility studies for water and related land resources consistent with the previously stated requirements of P&S. A representation of this framework or planning process is provided in Figure 1.2. This process involves three separate stages of plan development: development of a Plan of Study, development of intermediate plans; and development of detailed plans utilizing the four functional planning tasks of problem identification, formulation of alternatives, impact assessment, and evaluation. More specific attention is given to the planning process throughout Sections 4, 5, and 6.

The study will use existing economic, environmental, and engineering data when available. When data gaps are identified and a need for the data exists, detailed studies and investigations will be conducted throughout the feasibility study. Corps of Engineers personnel will be utilized to manage and budget for the study.

The services of an Architect/Engineer firm will be contracted to conduct all phases of Stage 2 and Stage 3 with the exception of fish and wildlife studies. These latter studies will be conducted by U. S. Fish and Wildlife Service under an Interagency Agreement between the Corps and USF&WS.

1.5.2 REPORT

The results of each stage of study development will be documented and presented in a report format at the end of each stage. These reports will be furnished to other agencies and publics for review and comment along with serving as internal management documents.

The first report, presented herewith, is the Reconnaissance Report which reflects the results of Stage 1 in the study process. It sets forth the justification for the study, documents the findings of the tasks undertaken to date, and establishes a program for managing the study. This report is also the basis for review and approval of completed and future study efforts by higher authority.

Results of Stage 2 and Stage 3 will be presented in the Preliminary Feasibility Report (PFR) and the Final Feasibility Report (FFR), respectively. These reports will present the development of plans, and the

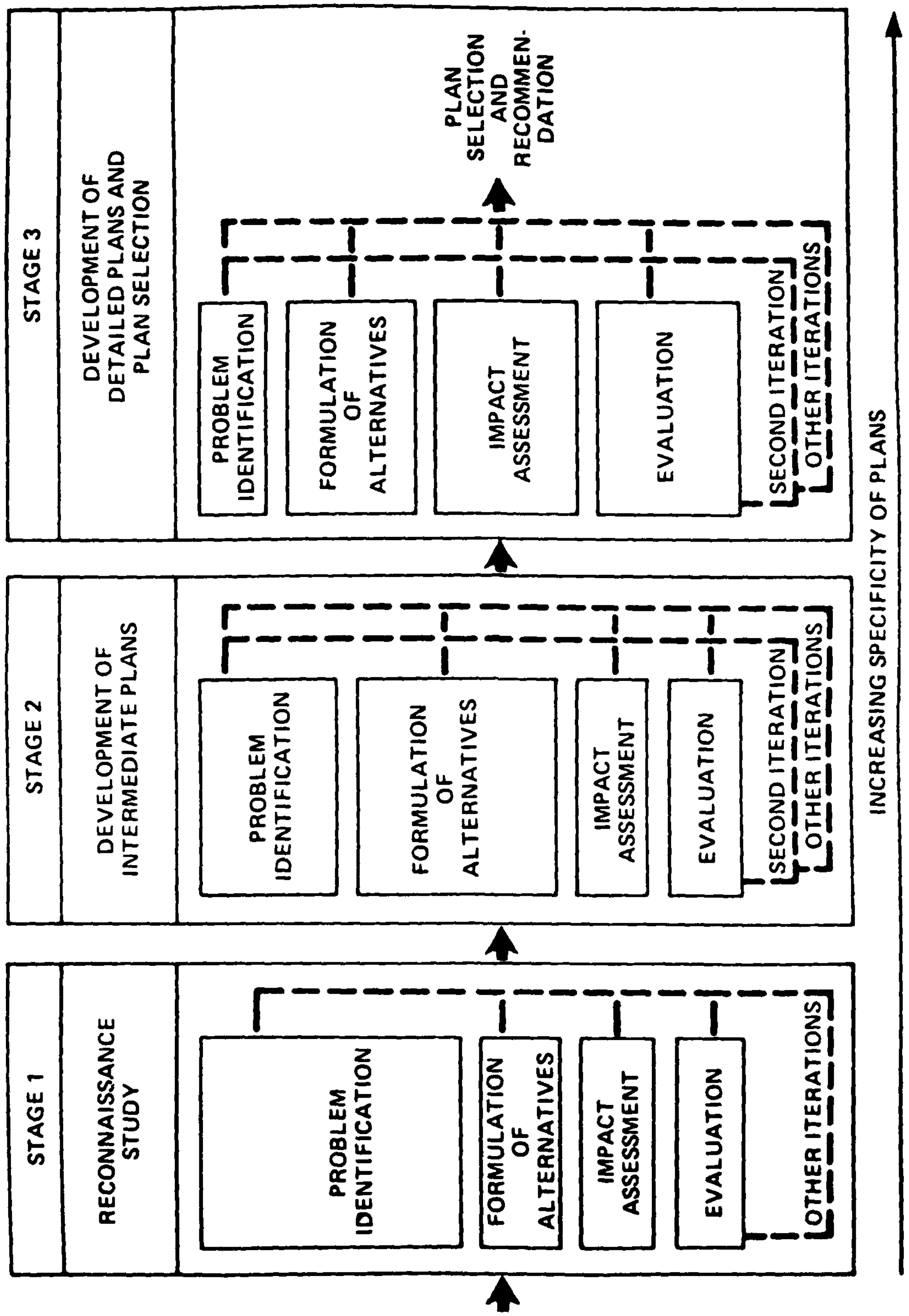
STAGE 1
RECONNAISSANCE STUDY
PROBLEM IDENTIFICATION
FORMULATION OF ALTERNATIVES
IMPACT ASSESSMENT
EVALUATION
OTHER ITERATIONS
STAGE 2
DEVELOPMENT OF INTERMEDIATE PLANS
PROBLEM IDENTIFICATION
FORMULATION OF ALTERNATIVES
IMPACT ASSESSMENT
EVALUATION
SECOND ITERATION
OTHER ITERATIONS
STAGE 3
DEVELOPMENT OF DETAILED PLANS AND PLAN SELECTION
PROBLEM IDENTIFICATION
FORMULATION OF ALTERNATIVES
IMPACT ASSESSMENT
EVALUATION
SECOND ITERATION
OTHER ITERATIONS
PLAN SELECTION AND RECOMMEN- DATION
INCREASING SPECIFICITY OF PLANS

Figure 1.2

assessment and evaluation of their impacts. The specificity of the reports increases as the study progresses towards completion. The FFR and its recommendations will be subject to reviews by the Board of Engineers for Rivers and Harbors, the Office of the Chief of Engineers, the Governor of the State of New York, Secretaries of the various prescribed Federal agencies, Secretary of the Army, the Water Resources Council, Office of Management and Budget, and finally, the Congress.

The National Environment Policy Act (NEPA) of 1969 requires Federal agencies to assess and document the effect or impacts of proposed actions on the environment in an Environmental Impact Statement (EIS). In compliance with this requirement, if the results of Stage 2 planning, to include an environmental assessment, indicate probable significant environmental impacts of the Corps action(s), an EIS will be prepared in conjunction with the study report and included in the final report for agency and public review and comment.

The report presented herein is the Reconnaissance Report which has been prepared to provide documentation of the results of the first stage of study development, Stage 1, in order to provide for higher authority review, and public and agency review of the study process.

The Main Report is presented in a concise and abbreviated format to enable condensed review. Appendices are provided to present more detailed discussions of respective topics.

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SECTION 2
EXISTING CONDITIONS

LAKE ONTARIO SHORELINE PROTECTION STUDY

SECTION 2

EXISTING CONDITIONS

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SECTION 2 - EXISTING CONDITIONS

An accurate and comprehensive environmental, social, and economic resource data base is essential to effective planning for development of water resources. Paramount to this data base development is the early identification of existing conditions. This data base is then refined throughout the study giving a rational basis for assessment and evaluation of likely consequences of alternative plans and for finally selecting a plan of action for recommendation. It will also furnish a basis for evaluating the need for enhancement, mitigation, or replacement measures.

At this stage of the study, the needed resource data base is one that is sufficient to provide a useful profile of existing physiographic, biological, aesthetic, cultural, social, and economic elements, that constitute the area's natural and human environment. The intent is to determine, as early as possible, those resources which should be preserved, enhanced, protected, or approached with care. Other purposes of this initial activity are to identify data gaps and deficiencies, and to determine if a monitoring program of selected resource components needs to be initiated to establish baseline conditions. The study efforts required to fill these gaps will be conducted during subsequent study stages.

This section is devoted to briefly identifying this resource data base. The level of comprehensiveness and detail is dependent upon that which is already known about the study area via existing literature and/or has been described and identified by previous studies and reports, and upon that which is required to meet the needs of this stage of study development, i.e., reconnaissance.

Shoreline environments represent an interface between a number of environmental systems, both natural and human. Alterations to either system could impact not only the system being altered, but also could affect a number of related or seemingly unrelated systems to varying degrees. The existing general shoreline environmental profile in this section is presented from two aspects: (1) the natural environment, characterized by the physical, geological, atmospheric and biological features; and (2) the human environment, characterized by the demographic, social, cultural, and economic features.

Also, to assist in defining this resource base, a physical shoreline inventory was conducted by the Great Lakes Laboratory of the State University College at Buffalo. To standardize the data and to make it compatible with an earlier inventory conducted by the International Great Lakes Levels Board, the shoreline was divided into 126 reaches. A reach is defined as having a relatively homogeneous physiography, geography and economic-social value. The shoreline was also standardized with a system of reference mileage, which

like the reaches, were defined in 1966 for the above-mentioned Board. Plate 1, which follows at the end of Appendix A, shows these standardized systems and is provided for easy reference. In addition to the open-lake shoreline, the following bay shorelines were also included: Chaumont Bay, Black River Bay, Henderson Bay, North Colwell Bay, North Pond, Little Sodus Bay, Blind Sodus Bay, Port Bay, East Bay, Sodus Bay, and Irondequoit Bay. The inventory consisted of gathering economic, geologic, environmental, and engineering data for each reach.

NATURAL ENVIRONMENT

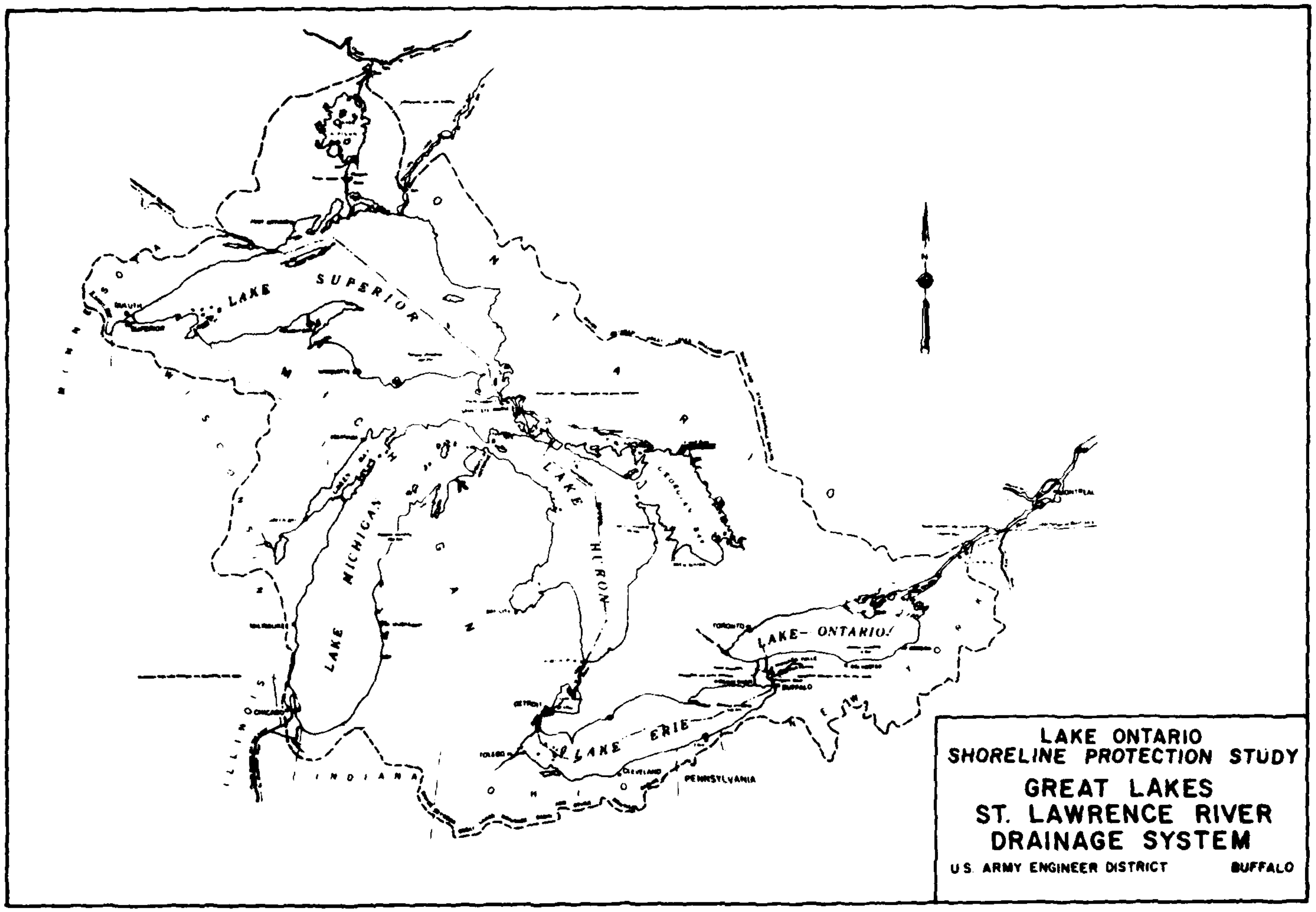
2.1 PHYSIOGRAPHY

2.1.1 GEOGRAPHY

The Great Lakes basin shown on Figure 2.1 constitutes the major part of the Great Lakes-St. Lawrence River drainage basin, extending from the westerly end of Lake Superior to the Gulf of St. Lawrence on the Atlantic Ocean, a water-route distance of more than 2,000 miles. The five Great Lakes . . . Superior, Michigan, Huron, Erie, and Ontario . . . with their connecting rivers and Lake St. Clair, have a water surface area of about 95,000 square miles. The lakes lie partially in the United States, and partially in Canada except for Lake Michigan which lies wholly within the United States. The total area of the Great Lakes basin, both land and water, above the easterly end of Lake Ontario is approximately 296,000 square miles of which 174,000 square miles are in the United States and 122,000 square miles are in Canada. Based on their basin configurations, there are five Great Lakes as noted above. However, because of the wide, deep channel called the Straits of Mackinac which connects Lake Michigan and Lake Huron, these lakes, hydraulically are one. Therefore, they will be referred to in this discussion as Lake Michigan-Huron.

In the system, the outflows from Lake Superior discharge into Lake Michigan-Huron; those of Lake Michigan-Huron flow into Lake Erie; those from Lake Erie into Lake Ontario; and those from Lake Ontario through the St. Lawrence River to the Atlantic Ocean. Regulation of the outflows of Lake Superior affects the timing of flow into Lake Michigan-Huron, which in turn modifies the water supplies to the lakes situated further downstream. Similarly, regulation of Lake Ontario affects the water levels downstream in the St. Lawrence River. The average surface levels of the lakes above sea level decrease from an average of about 600 feet above sea level for Superior to about 245 feet above sea level for Ontario.

The Great Lakes are naturally divided into the upper Great Lakes (Superior and Michigan-Huron) and the Lower Great Lakes (Erie and Ontario). The lakes within these divisions have many similarities. Lakes Superior and Michigan-Huron are the largest in area and volume. Their overall environmental state is good: oligotrophic or moderately mesotrophic. Their ratio of drainage area to water volume is low (30 square miles of drainage to every cubic mile of volume). Their range of levels is much smaller than that of the lower Great Lakes.



LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
ONTARIO
MICHIGAN
WISCONSIN
OHIO
INDIANA
ILLINOIS
PENNSYLVANIA
TORONTO
BUFFALO
DETROIT
TOLEDO
CLEVELAND
CHICAGO
MILWAUKEE
DULUTH
MONTREAL
LAKE ONTARIO
SHORELINE PROTECTION STUDY
GREAT LAKES
ST. LAWRENCE RIVER
DRAINAGE SYSTEM
U.S. ARMY ENGINEER DISTRICT BUFFALO

Figure 2.1

On the other hand, the lower Great Lakes are the smallest in area and volume. Their environmental state is low-mesotrophic to eutrophic. The ratio of drainage area to water volume is high (90:1 as opposed to 30:1 for the upper Great Lakes). Their range of levels is much greater than that of the upper Great Lakes. The longitudinal axis of both lakes has virtually the same alignment which also corresponds to prevailing west-southwest wind direction in the area. Both of the lower Great Lakes have a higher percentage of erodible shoreline than the upper Great Lakes.

Because of these similarities within groupings, the lower Great Lakes have problems peculiar to themselves which do not exist on the upper Great Lakes. They are:

- Lakewide pollution.
- Relatively quick and severe response of their levels and flows to extremes of supply (floods or droughts).
- A large percentage of "problem" shoreline.
- High impact on hydropower generation.
- Similar tributary hydrology, including "snowbelts" with unique spring flooding problems.
- Frequent occurrence of, and sensitivity to, southwest winds.

The Lake Ontario basin, shown on Figure 2.2, comprises 33,400 square miles including land and water, or 11 percent of the total Great Lakes drainage. This number includes only direct local drainage from Lake Ontario and Niagara River tributaries. Technically, the drainage area of Lake Ontario is the local drainage to the lake plus all the drainage to the other Great Lakes. For purposes of this report, "Lake Ontario drainage" and "Lake Ontario basin" will refer to the drainage excluding drainage upstream of the head of the Niagara River.

3,500 square miles of Lake Ontario's water surface lie in the United States (New York State), while over half the surface, 3,900 square miles, is in Canada, all in the Province of Ontario. The United States land area of the Lake Ontario basin, all in either New York or Pennsylvania, is 14,400 square miles. The Canadian land area located in Ontario and Quebec, is 11,600 square miles. Table 2.1 gives land and water surface areas for each of the Great Lakes. The table shows that Lake Ontario has the smallest local drainage area and the smallest water surface area.

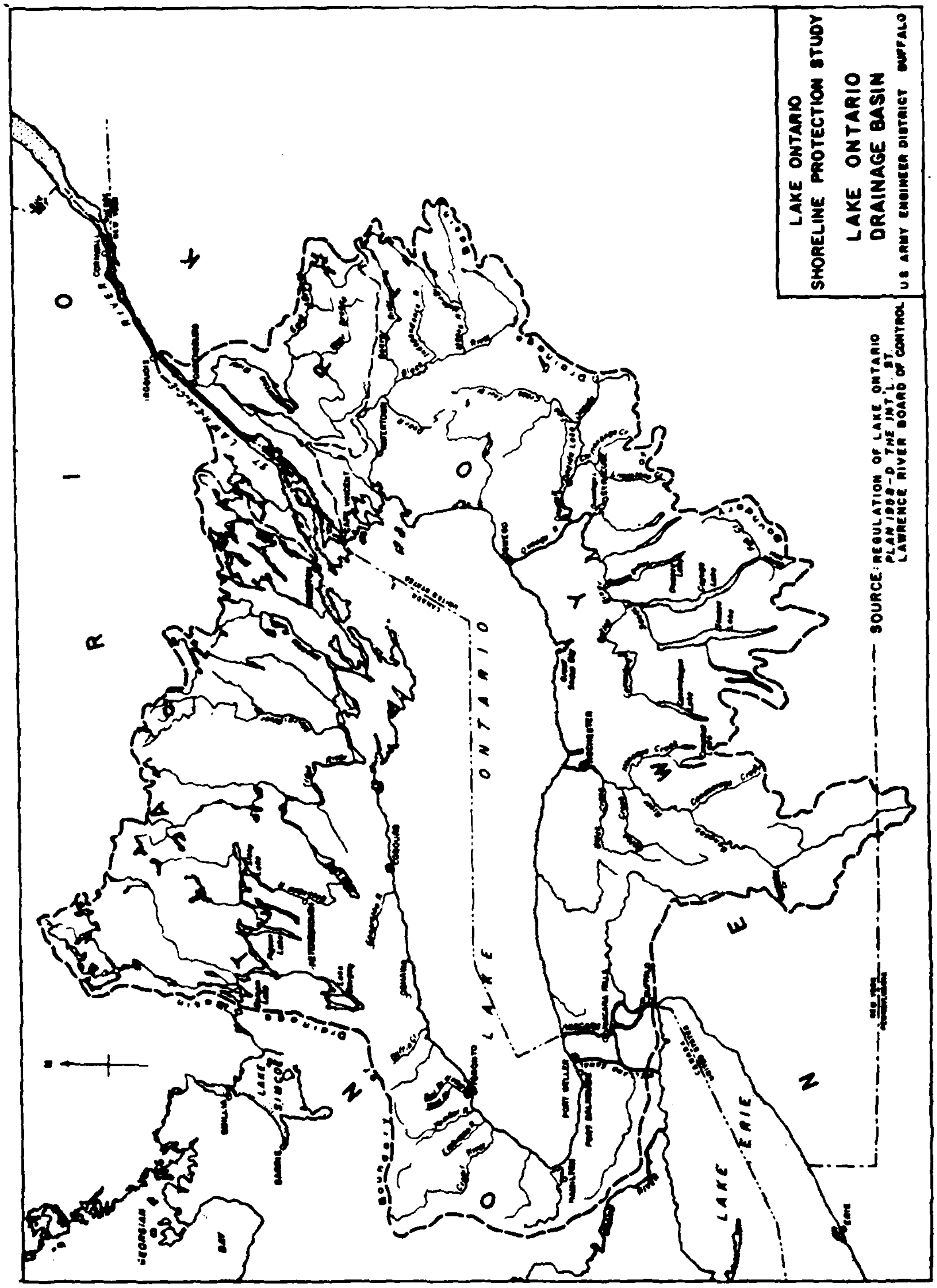

LAKE ONTARIO
SHORELINE PROTECTION STUDY
LAKE ONTARIO
DRAINAGE BASIN
U.S. ARMY ENGINEER DISTRICT BUFFALO
SOURCE: REGULATION OF LAKE ONTARIO PLAN 1958-D THE INT'L ST. LAWRENCE RIVER BOARD OF CONTROL
LAKE ONTARIO
LAKE ERIE

Figure 2.2

Table 2.1 - Great Lakes Basin Areas in Square Miles (Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, 1977)

	In Canada		In United States		Total
	Land	Water	Land	Water	Area
Lake Superior	32,400	11,100	16,900	20,600	81,000
St. Marys River	831	41	173	48	1,093
Lake Michigan	-	-	45,600	22,300	67,900
Lake Huron	34,700	13,900	16,000	9,100	73,700
St. Clair River	88	8	1,180	13	1,289
Lake St. Clair	3,780	268	1,020	162	5,230
Detroit River	213	16	648	23	900
Lake Erie	4,720	4,930	18,000	4,980	32,630
Niagara River	511	10	791	13	1,325
Lake Ontario	10,900	3,880	12,500	3,460	30,740
St. Lawrence River -					
Above Iroquois Dam	656	104	1,860	86	2,706
Above Power Dam	786	125	1,990	110	3,011

Note: Water areas are those only of lake or river named, smaller lakes, etc., within the basin being included with the land portion.

2.1.2 LAKE VOLUMES

The vast water storage area of the Great Lakes is unique among fresh water systems. Due to their size, relatively small changes in levels of the lakes account for enormous quantities of water. The total storage in 1 foot above low water datum on all the lakes would equal the mean flow of the St. Lawrence River for about 4 months. Low water datum is an arbitrary elevation on each lake to which chart and navigation depths are referred.

The total volume of all the Great Lakes at low water datum is approximately 5,440 cubic miles. Unless otherwise noted in this report, all volumes are computed using low water datum. This distinction is necessary since any level above low water datum would result in additional storage.

Lake Ontario, although it has the smallest surface area of all the Great Lakes, is not the smallest in volume. Its 393 cubic miles gives it more than three times the volume of the smallest, Lake Erie, which has a volume of 116 cubic miles.

At low water datum, a 1-foot change in the Lake Ontario water level would result in a change of volume of 1.4 cubic miles or about 80,000 cfs-months. Table 2.2 shows the volumes and rate of change in storage with level (at low water datum) for each of the Great Lakes.

Table 2.2 - Volumes of the Great Lakes at Low Water Datum* (Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, 1977)

Lake	Volume			Storage Per Foot of Level Change
	Cubic Miles	Acre-Feet X 10^9	Percent of Total	CFS-Months
Superior	2,900	10.0	54	337,000
Michigan-Huron	2,030	6.9	37	581,000
Erie	116	0.4	2	105,000
Ontario	393	1.3	7	80,000
Total	5,439	18.6	100	1,003,000

*Low water datum is an arbitrary elevation on each lake to which chart and navigation depths are referred.

2.1.3 BATHYMETRY

Since they are natural basins, the depths of the Great Lakes are not uniform. The depth of each lake varies irregularly. As with volumes, depths are related herein to low water datum for each lake. Accordingly, depths vary not only on a spatial basis, but with time, as absolute lake levels rise and fall. Actual depths are determined by adding to the depths given the algebraic difference between the absolute level and the low water datum. The average depth of a lake is the average volume at a given level, divided by the surface area at that level. The average depths, in feet, of the Great Lakes are: Superior, 489; Michigan-Huron, 244; Erie 62; and Ontario, 283.

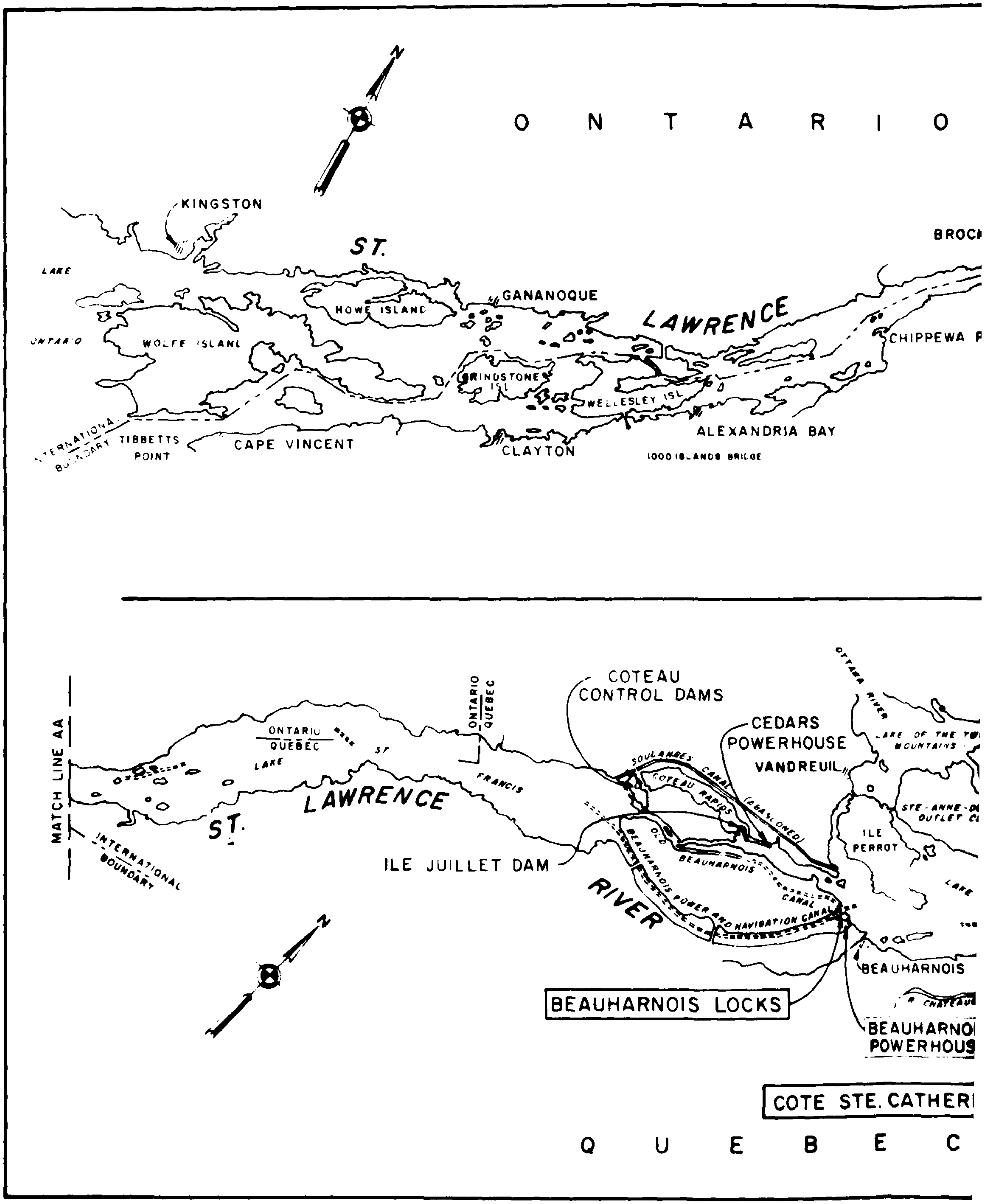
As noted above, the average depth of Lake Ontario is 283 feet. Ontario's longitudinal bottom profile slopes relatively gently from west to east. It reaches a maximum depth of 802 feet near its eastern end, about 25 miles north of Sodus Bay, NY. Continuing eastward, the bottom rises at a rapid rate, so that there is great asymmetry to the longitudinal profile. This longitudinal asymmetry is matched somewhat by a lateral asymmetry, with the bottom extending from the north shore much less steep than that from the south shore. A point of interest is that the deepest point in Lake Ontario is located well below sea level, as is the case in all Great Lakes except Erie. As stated above, Lake Ontario's deepest point is 802 feet below its surface. Its surface is located at approximately 245 feet above sea level. Hence, Lake Ontario's deepest point is about 557 feet below sea level.

2.1.4 OUTLET RIVERS

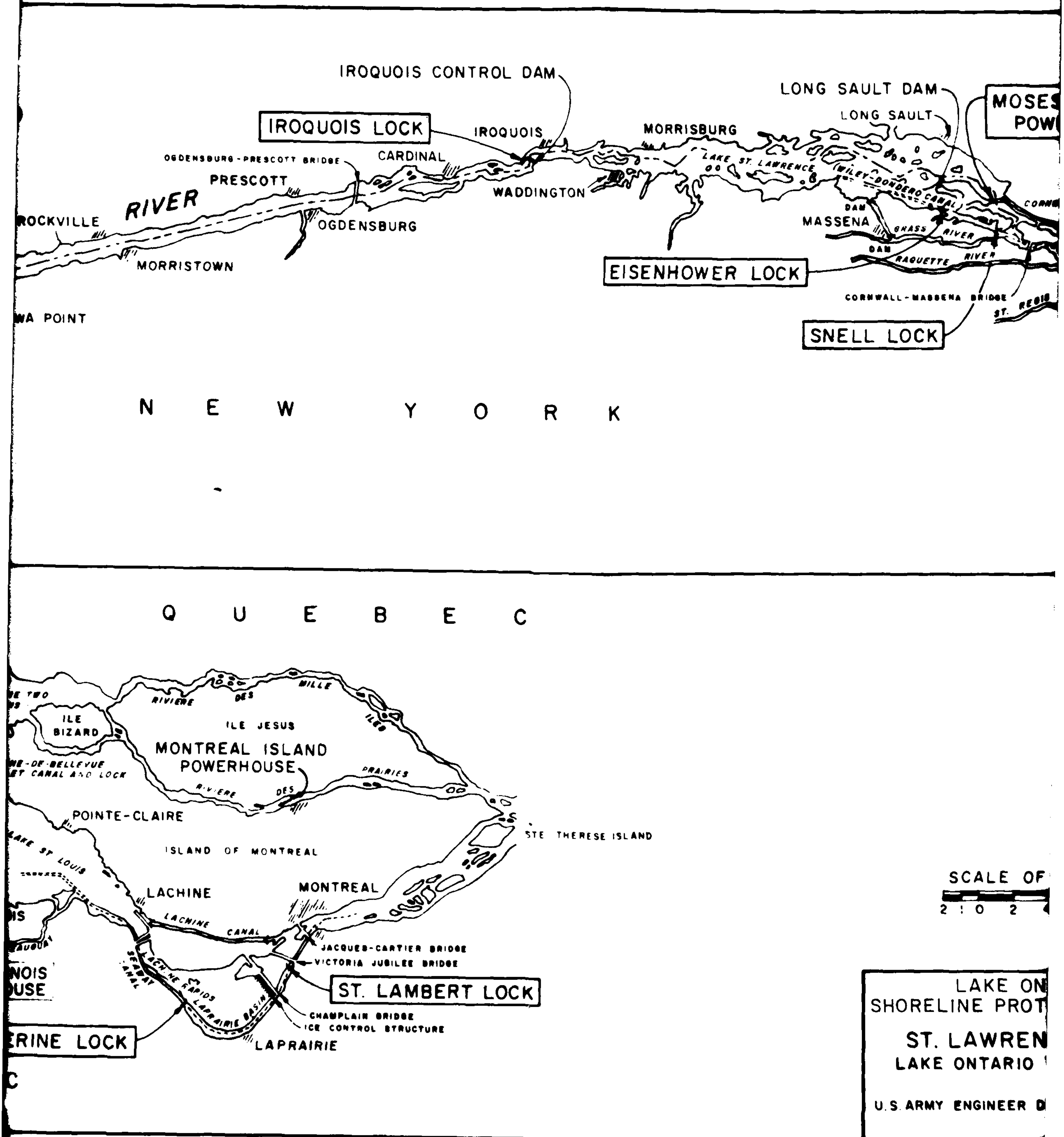
Lake Superior, the most northerly and furthest upstream of the Great Lakes, discharges through the St. Marys River at its eastern end into Lake Huron. The natural outlet of Lake Michigan is the broad and deep Straits of Mackinac. Although water can and does flow back and forth between Lakes Michigan and Huron, it has been estimated that the average contribution of Lake Michigan to Lake Huron is approximately 50,000 cubic feet per second. The outlet of Lake Huron is the St. Clair River at the extreme southern tip of the lake. The St. Clair River discharges southward into Lake St. Clair. The outlet of Lake St. Clair is the Detroit River, which flows southward into Lake Erie. The natural outlet of Lake Erie is the Niagara River, which discharges from the eastern end of the lake into Lake Ontario. The outlet of Lake Ontario is the St. Lawrence River, which flows in a northeast direction from the eastern end of the lake to the Gulf of St. Lawrence and the Atlantic Ocean.

The Niagara River forms the natural outlet from Lake Erie and is the major supplier to Lake Ontario. It flows out of Lake Erie in a northwesterly direction to Lake Ontario, a distance of approximately 36 miles with a fall of about 326 feet. The river falls about 5 feet in the first 4 miles below Lake Erie and about 4.5 feet in the next 19 miles as it widens and divides into two channels around Grand Island. Below Grand Island, it again becomes one channel and in the next mile falls 55 feet in the cascades and rapids above Niagara Falls. The river drops about 185 feet over the falls into the Maid-of-the-Mist Pool which extends about 2 miles below the falls. In the next 3 miles, the river drops about 76 feet through the Whirlpool Rapids. The fall is about one-half foot in the 7-mile reach from the foot of the Whirlpool Rapids to Lake Ontario. This reach is affected by backwater from the level of Lake Ontario. The average outflow of the Niagara River into Lake Ontario is about 200,000 cfs.

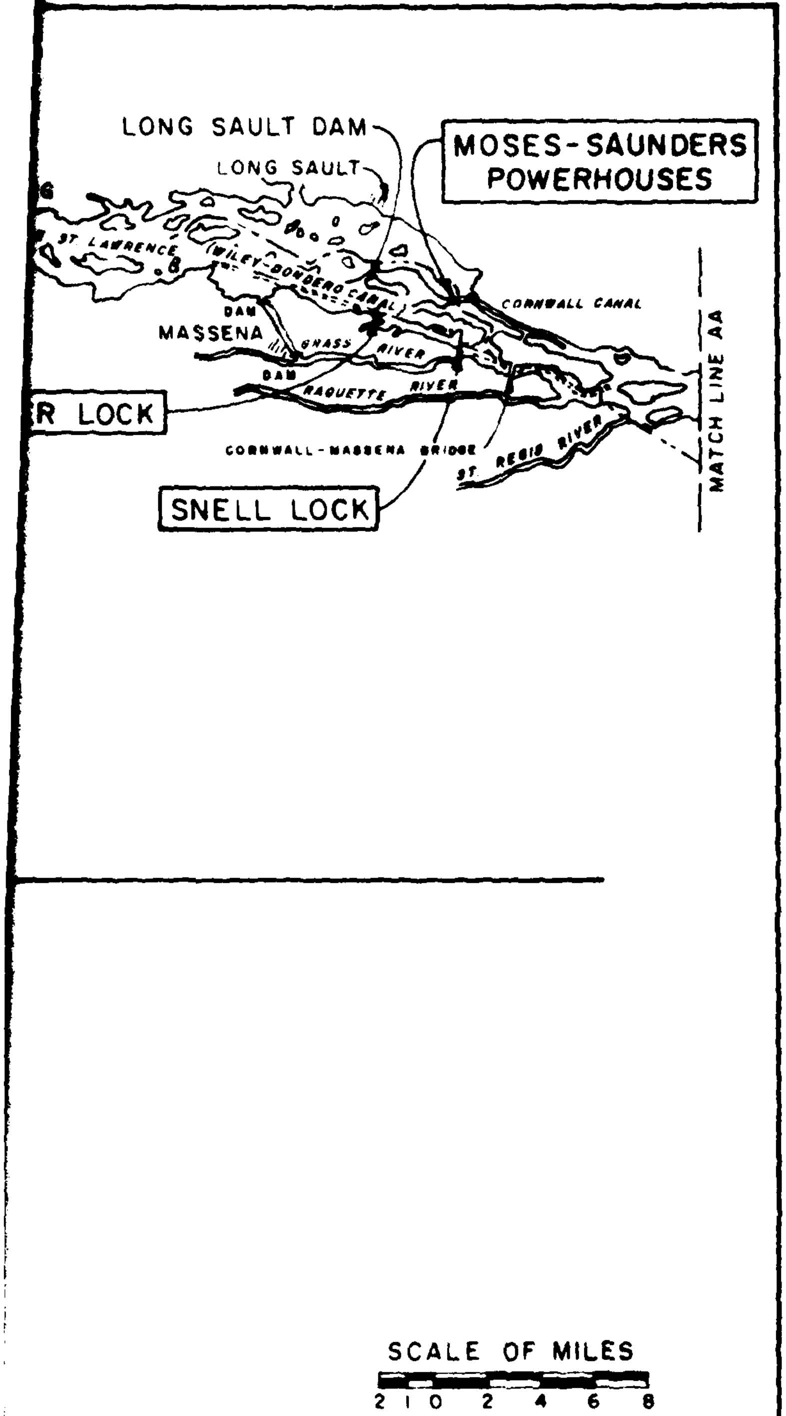
The St. Lawrence River is the outlet from Lake Ontario. It flows in a northeasterly direction to the Gulf of St. Lawrence, a distance of approximately 530 miles with a fall of about 245 feet (see Figure 2.3). The major portion of this fall, some 227 feet, occurs between Lake Ontario and Montreal Harbor, 183 miles from the lake. Located in this reach of the river is Iroquois Dam near Iroquois, Ontario; the Long Sault Dam between Barnhart Island and the United States shore near Massena, NY; two powerhouses, one on either side of the International Boundary between Barnhart Island and the Canadian shore near Cornwall, Ontario; and, the Eisenhower and Snell Locks. These structures were built as part of the St. Lawrence Seaway and Power Project. They control the outflows of Lake Ontario, which has been regulated since 1960 in accordance with criteria set forth by the International Joint Commission. A few miles below the Barnhart Island power plants, the river widens into Lake St. Francis, which, with the exception of a small area at the upstream end bounded by about 3 miles of United States shoreline, lies wholly within Canada. The levels of that lake have been fully controlled by the power plant at Beauharnois, Quebec, and the Coteau dams and the Cedars powerhouse at the lower end of the lake since 1943. There are also the Beauharnois Locks at this location. From Lake St. Francis, the river enters Lake St. Louis by the natural river channel and the Beauharnois Canal. Lake



N
ONTARIO
KINGSTON
ST.
BROCK
LAKE
ONTARIO
WOLFE ISLAND
HOWE ISLAND
GANANOQUE
LAWRENCE
CHIPPEWA
GRINDSTONE ISL
WELLESLEY ISL
ALEXANDRIA BAY
INTERNATIONAL BOUNDARY
TIBBETTS POINT
CAPE VINCENT
CLAYTON
1000 ISLANDS BRIDGE
MATCH LINE AA
ONTARIO
QUEBEC
LAKE
ST
FRANCIS
ST.
LAWRENCE
INTERNATIONAL BOUNDARY
ONTARIO
QUEBEC
COTEAU
CONTROL DAMS
CEDARS
POWERHOUSE
VANDREUIL
SOULANGES CANAL
COTEAU RAPIDS
(ABANDONED)
OTTAWA RIVER
ILE PERROT
OLD BEAUHARNOIS CANAL
BEAUHARNOIS POWER AND NAVIGATION CANAL
ILE JUILLET DAM
RIVER
BEAUHARNOIS
BEAUHARNOIS LOCKS
QUEBEC


IROQUOIS CONTROL DAM
LONG SAULT DAM
MOSES
POW
IROQUOIS LOCK
IROQUOIS
MORRISBURG
LONG SAULT
OGDENSBURG-PRESCOTT BRIDGE
CARDINAL
LAKE ST. LAWRENCE
PRESCOTT
WILEY-DONDERO CANAL
WADDINGTON
RIVER
ROCKVILLE
OGDENSBURG
MASSENA
DAM
GRASS
RIVER
RAQUETTE
RIVER
MORRISTOWN
EISENHOWER LOCK
CORNWALL-MASSENA BRIDGE
ST. REGIS
WA POINT
SNELL LOCK
N E W Y O R K
Q U E B E C
RIVIERE DES MILLE ILES
ILE BIZARD
ILE JESUS
MONTREAL ISLAND
POWERHOUSE
RIVIERE DES PRAIRIES
POINTE-CLAIRE
STE THERESE ISLAND
LAKE ST LOUIS
ISLAND OF MONTREAL
LACHINE
MONTREAL
SCALE OF
2 0 2
LACHINE CANAL
JACQUES-CARTIER BRIDGE
VICTORIA JUBILEE BRIDGE
SEAWAY CANAL
LACHINE RAPIDS
LAPRAIRIE BASIN
ST. LAMBERT LOCK
CHAMPLAIN BRIDGE
ICE CONTROL STRUCTURE
LAPRAIRIE
ERINE LOCK
LAKE ON
SHORELINE PROT
ST. LAWREN
LAKE ONTARIO
U.S. ARMY ENGINEER D

2



LAKE ONTARIO
SHORELINE PROTECTION STUDY

ST. LAWRENCE RIVER
LAKE ONTARIO TO MONTREAL

U.S ARMY ENGINEER DISTRICT BUFFALO

FIGURE 2.3

3

St. Louis also receives part of the flow of the Ottawa River. From the outlet of Lake St. Louis to Montreal Harbor, a distance of about 13 miles, the fall in the river is about 47 feet, 33 feet of which occur in the Lachine Rapids. The flow of the St. Lawrence River at Cornwall-Massena has averaged about 232,000 cubic feet per second, and at Montreal, about 270,000 cubic feet per second.

2.1.5 VARIATION IN RIVER FLOWS

The variation in flows of the Niagara and St. Lawrence Rivers, as well as the other Great Lakes outlet rivers recorded during the 1900-1977 period, is shown by the recorded maximum and minimum monthly flows given in Table 2.3.

Table 2.3 - Recorded Monthly Mean River Flows
(Cubic Feet Per Second 1900-1977)

Outlet River	Maximum	Minimum	Average
St. Marys	127,000	41,000	75,000
St. Clair	232,000	106,000	180,000
Detroit	233,000	112,000	184,000
Niagara	265,000	116,000	196,000
St. Lawrence (Cornwall-Massena)	350,000	154,000	238,000

2.2 TOPOGRAPHY

The Lake Ontario basin is the smallest of the five Great Lakes basins, but contains some of the largest watersheds. The Oswego, Genesee, Black, and Oswegatchie Rivers are the largest watersheds within the Lake Ontario basin. Streams tributary to the lake have a dendritic drainage pattern with many having deeply incised valleys.

Four major physiographic provinces are represented in the basin. The Appalachian Plateaus province includes the hilly uplands covering the southern half of the Genesee and Oswego drainage basins and the unique Finger Lakes region. All the lowlands bordering Lake Ontario and extending along the St. Lawrence River through the Thousand Islands are a part of the eastern lake section of the Central Lowland province. The broad lowland area extending along the St. Lawrence River is within the St. Lawrence Valley province. The Adirondack province is represented in the mountainous headwaters of the Black, Oswegatchie, and Grass-Raquette-St. Regis River systems.

The Adirondack Mountains are the highest land forms in the Great Lakes Basin. Thus, the Lake Ontario basin has the greatest extremes in topography of the five Great Lakes basins, falling from more than 4,000 feet in the

mountains to around 240 feet at the lake shore. Generally, the land is flat in Niagara and Orleans Counties. This changes to gentle-rolling hills through Monroe, Wayne, Cayuga and western Oswego Counties. The land becomes steeper in the remainder of Oswego County, Jefferson, and St. Lawrence Counties.

2.3 GEOLOGY

2.3.1 GEOMORPHOLOGY

Based on geomorphic criteria, the U. S. coastline of Lake Ontario can be classified into nine geomorphic units (Figure 2.4). The criteria used for this classification primarily include the shoreline configuration, physiographic and geologic nature of the bluffs, and the response characteristics of the bluffs to littoral processes. Reaches and mileage are referred to in Plate 1 at the end of Appendix A. The geomorphic units include:

a. Straight Lake Plain-Bluff, Type 1 - The Niagara and Orleans County shorelines are of this type. Steep bluffs up to 60-feet high in this area are subject to wave erosion and mass wasting processes. (Reach Nos. 1 to 25)

b. Eroding Headlands with Bay Beaches, Types 2, 5, and 7 - The shorelines of Eroding Headlands Units are characterized by sinuous shorelines with headlands skewed to the east, sandy or gravelly bay beaches, and bluffs with exposed bedrocks at the base. The headland orientation and geometry may be partially controlled by the joint patterns in the bedrock. The three divisions of the Eroding Headlands Unit are mainly based on their erosional response criteria to littoral processes. Examples of each of the three types follow:

(1) Eroding Headlands with Bay Beaches - Type 2
The western Monroe County shoreline (Reach Nos. 26 to 37)

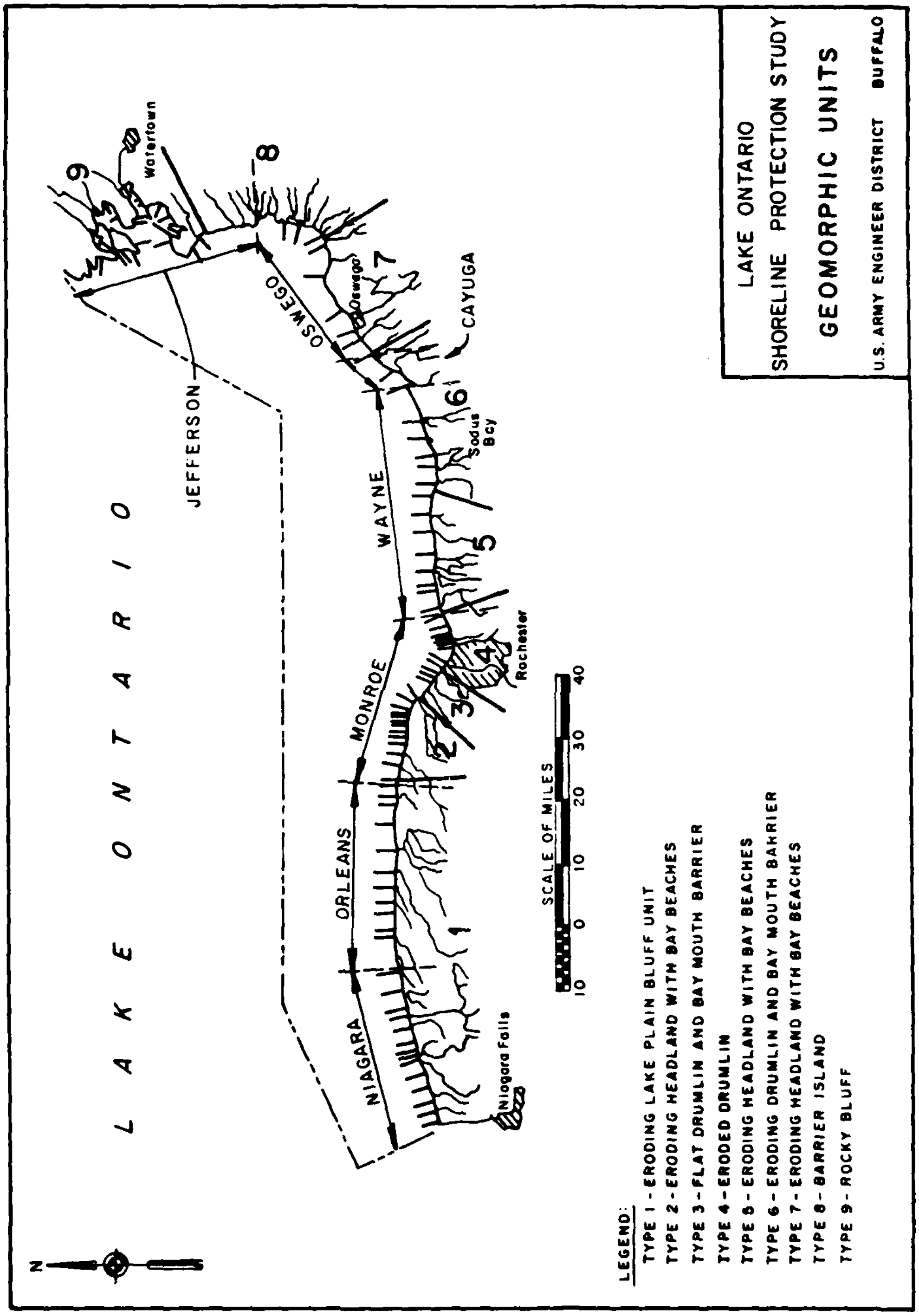
(2) Eroding Headlands with Bay Beaches - Type 5
The western Wayne County shoreline (Reach Nos. 50 to 57)

(3) Eroding Headlands with Bay Beaches - Type 7
The western Oswego County shoreline (Reach Nos. 85 to 90)

c. Flat Drumlin and Bay Mouth Barrier, Type 3 - The shoreline is characterized by low flat drumlins with wetlands and bays on the areas between drumlins. Long narrow barriers separate the lake from the wetlands and bays. The eastern Monroe County shoreline is included in this unit. (Reach Nos. 38 to 41)

d. Eroded Drumlins, Type 4 - The highly urbanized, sandy shoreline near the mouth of the Genesee River is included in this unit. (Reach Nos. 42 to 49; Reach Nos. 58 to 68 are in Sodus Bay; however, they closely resemble this type.)

e. Eroding Drumlin and Bay Mouth Barrier, Type 6 - Extremely high (up to 150 feet) drumlin bluffs separated by marshes which are fronted by barrier



LAKE ONTARIO
SHORELINE PROTECTION STUDY
GEOMORPHIC UNITS
U.S. ARMY ENGINEER DISTRICT BUFFALO
LAKE ONTARIO
JEFFERSON
OSWEGO
WAYNE
MONROE
ORLEANS
NIAGARA
CAYUGA
Watertown
Oswego
Sodus Bay
Rochester
Niagara Falls
SCALE OF MILES
10 0 10 20 30 40
N
LEGEND:
TYPE 1 - ERODING LAKE PLAIN BLUFF UNIT
TYPE 2 - ERODING HEADLAND WITH BAY BEACHES
TYPE 3 - FLAT DRUMLIN AND BAY MOUTH BARRIER
TYPE 4 - ERODED DRUMLIN
TYPE 5 - ERODING HEADLAND WITH BAY BEACHES
TYPE 6 - ERODING DRUMLIN AND BAY MOUTH BARRIER
TYPE 7 - ERODING HEADLAND WITH BAY BEACHES
TYPE 8 - BARRIER ISLAND
TYPE 9 - ROCKY BLUFF

Figure 2.4

beaches characterize the Eroding Drumlin and Bay Mouth Barrier shorelines. Bluffs are composed of glacial tills. Slumping and rill erosion dominate bluff erosion processes in this area. (Reach Nos. 69 to 84)

f. Barrier Island, Type 8 - The north-south oriented shoreline of Oswego and Jefferson Counties which are characterized by wide sandy beaches, long narrow barrier islands and their associated dunes are separated by narrow inlets and are included in this unit. (Reach Nos. 91 to 96)

g. Rocky Bluff, Type 9 - The high rocky, often-terraced bluffs along the deep bay shoreline of northern Jefferson County are included in this unit. Occasional wetlands and pocket beaches between headlands characterize this section of shoreline. (Reach Nos. 97 to 126)

2.3.2 STRATIGRAPHY

Bedrock is exposed at several locations along the shoreline and in offshore areas. The influence of bedrock on shore morphology and recession rates seems to be significant. The bedrock of the Lake Ontario shoreline area consists of a sequence of Middle to Late Ordovician formations which slope gently southward and are highly jointed. Two sets of joints predominate, N 10°E and N 70°E. The lithologic characteristics and their distributions are as follows. The distribution pattern of the bedrock is presented in Figure 2.5.

a. Trenton Group (Reach Nos. 96 to 126) - Present at the Rocky Bluff geomorphic unit of northern Jefferson County and consists mainly of calcareous shales of Middle Ordovician age.

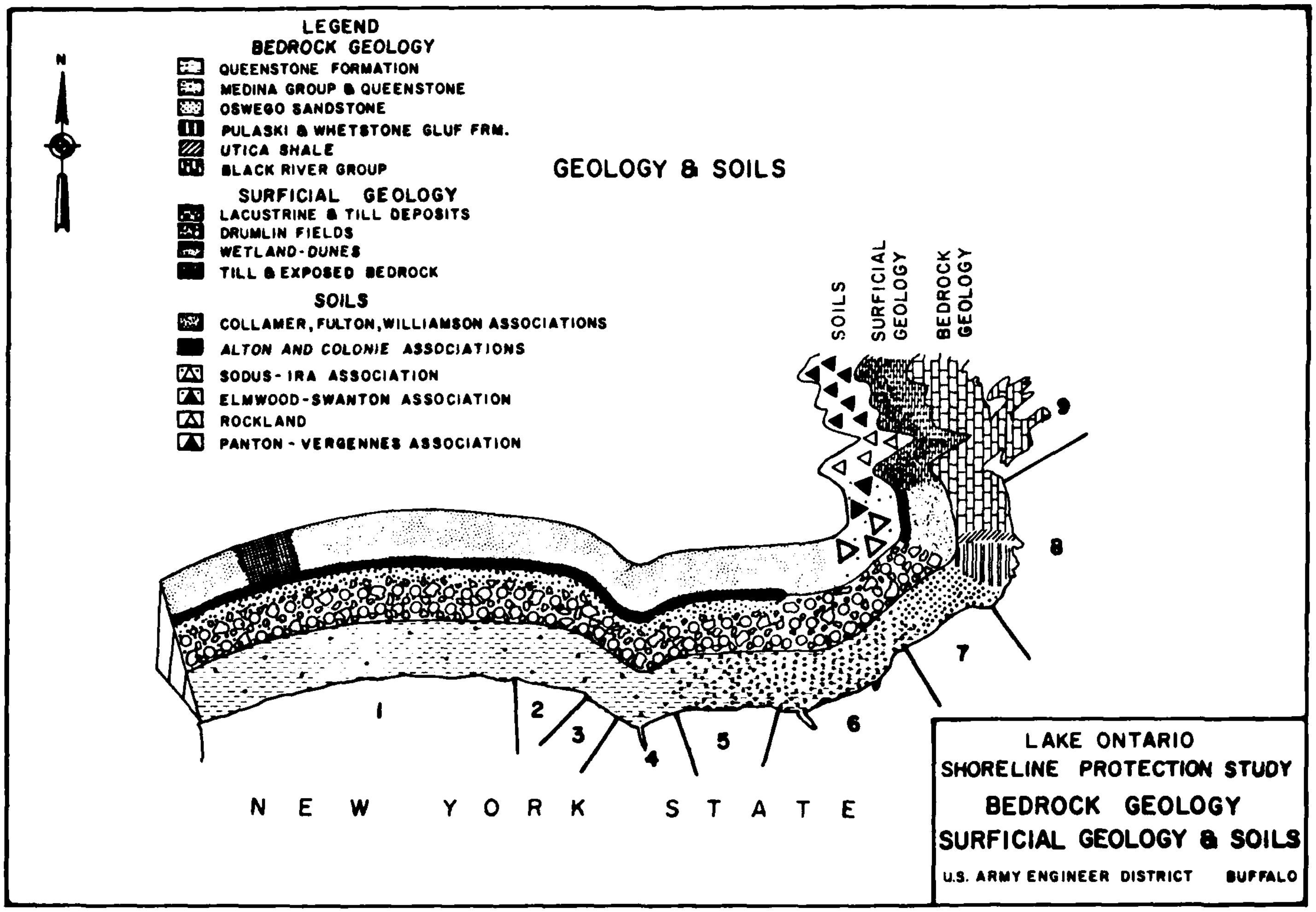
b. Black River Group (Reach Nos. 96 to 126) - Mainly of dolostone and highly fossiliferous limestones of Middle Ordovician age. Present in the same area as above.

c. Utica Shale (Reach Nos. 93, 95, and 96) - A gray fossiliferous, calcareous shale of Ordovician age. Present at North Pond and in the subsurface of the Barrier Island geomorphic unit.

d. Oswego Sandstone (Reach Nos. 85 to 90) - A nonfossiliferous fine to medium-grained gray sandstone of fluvial origin. It is more resistant than other formations exposed at the shoreline. Present along the Eroding Headland-Type 7 geomorphic unit in Oswego County.

e. Medina Group (Reach Nos. 53 to 85) - Interbedded red sandstone, siltstone, and red-green shale. Present at Eroding Headland-Type 5 and subsurface of Eroding Drumlin-Type 6 geomorphic units in Wayne and Cayuga Counties.

f. Queenston Formation (Reach Nos. 1 to 52) - Calcareous and argillaceous sandstones, calcareous shales, and siltstones. Present along with the Medina Group in Wayne and Cayuga Counties and along the entire western shoreline.



LEGEND
BEDROCK GEOLOGY
QUEENSTONE FORMATION
MEDINA GROUP & QUEENSTONE
OSWEGO SANDSTONE
PULASKI & WHETSTONE GLUF FRM.
UTICA SHALE
BLACK RIVER GROUP
SURFICIAL GEOLOGY
LACUSTRINE & TILL DEPOSITS
DRUMLIN FIELDS
WETLAND-DUNES
TILL & EXPOSED BEDROCK
SOILS
COLLAMER, FULTON, WILLIAMSON ASSOCIATIONS
ALTON AND COLONIE ASSOCIATIONS
SODUS-IRA ASSOCIATION
ELMWOOD-SWANTON ASSOCIATION
ROCKLAND
PANTON-VERGENNES ASSOCIATION
N
GEOLOGY & SOILS
SOILS
SURFICIAL GEOLOGY
BEDROCK GEOLOGY
1
2
3
4
5
6
7
8
9
NEW YORK STATE
LAKE ONTARIO
SHORELINE PROTECTION STUDY
BEDROCK GEOLOGY
SURFICIAL GEOLOGY & SOILS
U.S. ARMY ENGINEER DISTRICT BUFFALO

Figure 2.5

g. Clinton Group (Reach Nos. 60 to 66) - Present only along the shoreline of Sodus Bay. Made up of limestones, shales, sandstones, and hematite.

The shoreline area can be divided into four broad zones (Figure 2.5) based on surficial geology. The lake plain surficial unit extends from the Niagara River to west of Sodus Bay. It consists of beach sediments, glacial tills, and lacustrine sediments. The drumlin surficial unit consists mainly of glacial till and it is found in Wayne, Cayuga, and Oswego Counties. The dune and wetland unit consists of dune sands and fine-grained marsh deposits and it occurs in Oswego and Jefferson Counties. (Reach Nos. 91 to 97) The bedrock and till unit is characterized by a thin soil layer of variable nature covering exposed bedrock. This unit occurs in northern Jefferson County. (Reach Nos. 98 to 126)

2.3.3 SOILS

The soils of the study area consist of six basic types (Figure 2.5):

a. Collamer, Fulton, Williamson Associations. Dominantly well to somewhat poorly drained soils. Dominated by medium-to-fine textured soil on glacial lake deposits.

b. Alton and Colonie Associations. Dominantly well-to-excessively drained, nearly level soils. Coarse textured soil on gravel and sand.

c. Sodus-Ira Association. Dominantly deep, well or moderately well drained sloping soil. Medium textured acid soil with neutral to slightly acid fragipans on glacial till.

d. Elmwood-Swanton Association. Dominantly well-to-excessively drained, nearly level soils. Coarse textured soil on gravel and sand.

e. Rockland. Nearly level to sloping, very shallow soils.

f. Panton-Vergennes Association. Dominantly somewhat poorly and poorly drained soil. Dominated by medium-to-fine textured soils on glacial lake sediments.

2.3.4 BEACH CHARACTERISTICS

The morphology of the beach was studied from the measurement of beach profiles at each reach. Beach width, berm heights, and beach-face slopes were measured from the plotted beach profiles.

The beach width, which is defined as the distance between the toe of the bluff and the stillwater line, ranged from 0 to 106 feet. In general, the beach width is less than 32 feet. More than 50 percent of the beaches of the Barrier Island geomorphic unit are more than 32 feet wide. (Figure 2.6) Beaches wider than 90 feet occur only in two geomorphic units. No beaches wider than 32 feet are observed in Eroding Headlands-Type 7 geomorphic units. The wider beaches, other than those of the barrier island shoreline in Oswego and Jefferson Counties are, in general, wider near shore perpendicular to

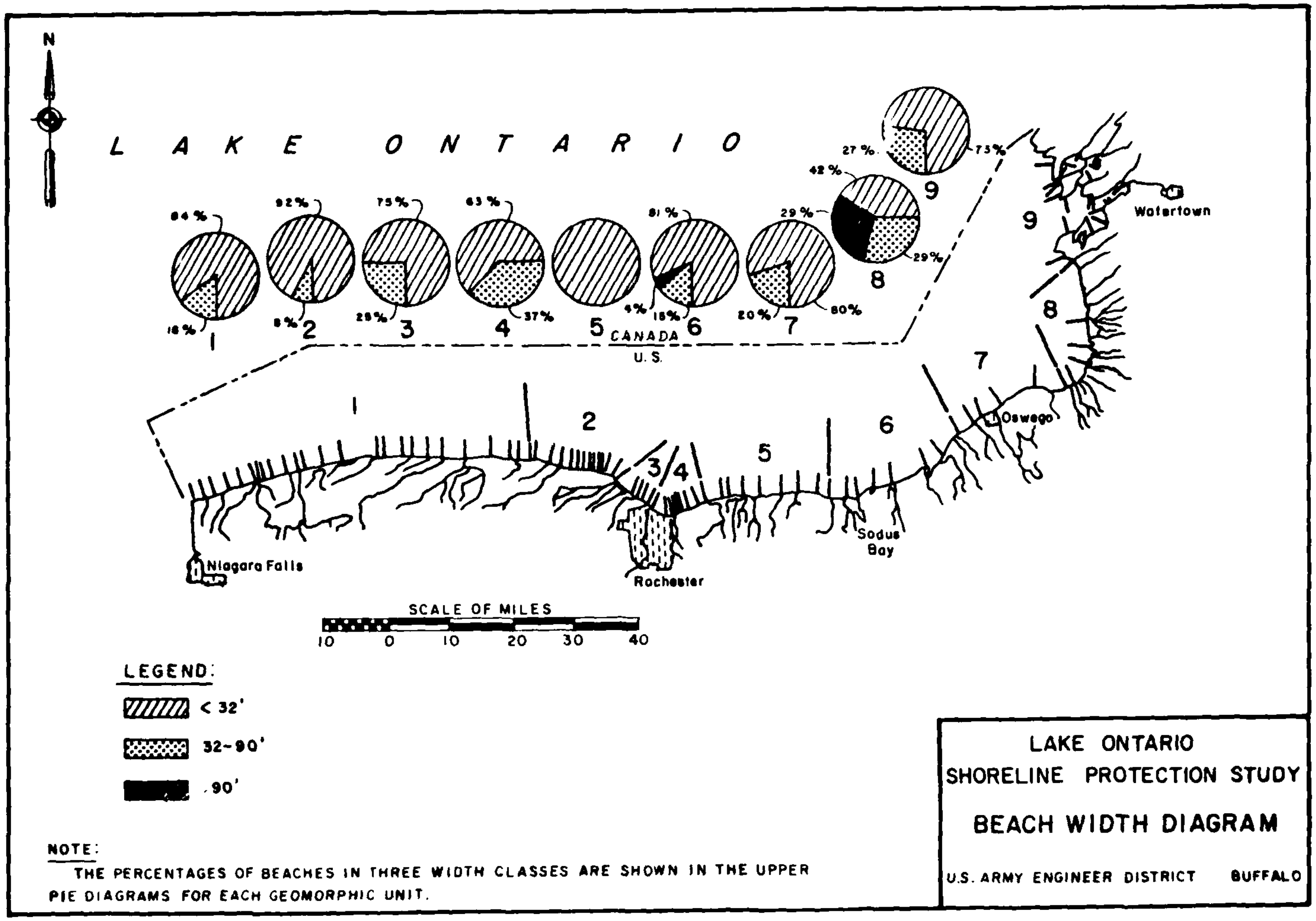

N
LAKE ONTARIO
84 %
16 %
1
92 %
8 %
2
75 %
25 %
3
63 %
37 %
4
5
81 %
4 %
15 %
6
29 %
20 %
80 %
7
42 %
29 %
8
27 %
73 %
9
CANADA
U. S.
1
2
3/4
5
6
7
8
9
Niagara Falls
Rochester
Sodus Bay
Oswego
Watertown
SCALE OF MILES
10 0 10 20 30 40
LEGEND:
< 32'
32-90'
90'
NOTE:
THE PERCENTAGES OF BEACHES IN THREE WIDTH CLASSES ARE SHOWN IN THE UPPER PIE DIAGRAMS FOR EACH GEOMORPHIC UNIT.
LAKE ONTARIO
SHORELINE PROTECTION STUDY
BEACH WIDTH DIAGRAM
U.S. ARMY ENGINEER DISTRICT BUFFALO

Figure 2.6

protective structures like groins or jetties. In eroding headlands areas with exposed bedrocks at the base of the bluff, narrow to nonexistent beaches near the headlands alternate with narrow (<32 feet) to moderately wide (32 to 90 feet) bay beaches.

The beach-face slope, which was measured at the active beach face, ranged from 4° for sandy beaches to 20° for gravel beaches. Grain shape and size are the controlling factors of beach-face slope. Flat gravel beaches possessed the steepest slopes.

Multilevel berms were observed on most of the beach profiles measured. The number of berms ranged from zero in erosional profiles to a maximum of four on depositional open-lake shore beaches.

2.3.5 BLUFF CHARACTERISTICS

The bluffs, which are gently sloping to near-vertical surfaces located at the landward edge of the beach, vary greatly in terms of their height, slope, and stability characteristics. The bluff height ranged from less than 10 feet above the Low Water Datum (LWD, 242.8 feet) in Orleans County to a maximum of 150 feet in Wayne County. In general, the bluffs in Niagara and Orleans Counties decrease in height in an eastward direction. Based on the lithologic composition, the bluffs have been classified into seven groups. Except for the lake plain bluff and eroded bluff geomorphic units, which indicate two groups of bluff types, the bluff grouping matches with the geomorphic units. The bluff types include:

a. Lake Plain Bluffs

b. Lake Plain with Bedrock Bluffs

c. Low Glacial Till Bluffs

d. Drumlin Bluffs

e. Glacial Till with Bedrock Bluffs

f. Dune Bluffs

g. Rocky Bluffs

The slope of the bluffs at the exposed shore ranges from 15° for a stabilized bluff to near vertical for a retreating bluff. The field-measured value, however, did not exceed 62° as profiles could not be measured at vertical scarps. A composite section of the bluffs on the southern shoreline is typified by several layers. The bottom-most layer is bedrock of varying properties and the top layer is glaciolacustrine deposits of Lake Iroquois. Brennan (1979) identified two till layers and an in-between lacustrine layer. All these layers, however, are not present in any reach. The maximum height of the upper surface of bedrock is about 6 to 10 feet above LWD. Rocky bluffs are high and nearly vertical with a thin till layer on top.

The stone content of the glacial bluffs ranged from less than 10 percent to 60 percent.

On a long-term basis, all the bluffs are erosional. A majority of the bluffs will become partially vegetated during the growing season. Extensive evidence of slumping and other mass wasting processes were commonly observed in Niagara and Wayne Counties.

2.3.6 OFFSHORE-NEARSHORE AREA CHARACTERISTICS

The nearshore (less than 50 feet in depth) area was studied with the help of 64 fathometer profiles taken during the field survey. The offshore slopes were determined from these profiles. Four to five equally spaced Ponar Grab samples were also collected from each profile.

The offshore profiles were grouped into barred and nonbarred on the basis of the presence or absence of nearshore bars. The barred profiles are located near Rochester and in the eastern part of the lake. Areas with sub-aquatic eroding glacial tills and some rocky-bottom areas indicated an uneven profile. The sandy bottom indicated a smooth profile. Both rocky-bottom and glacial till areas often indicated a stepped or irregular profile where the slope changed erratically. The nearshore slope varied extensively at various segments of a profile or between profiles. Slopes as high as 13° were observed close to the shore (less than 10 feet in depth). In general, the steepest slope in excess of 1° was observed very close to the shore for the open-lake shoreline. The nearshore slope was grouped into three classes: gentle (<.2°), moderate (.2 to .4°), and steep (<.4°). Based on this slope classification, the nearshore slope variation of Lake Ontario is presented in Figure 2.7. The nearshore area west of Braddock Bay is characterized by moderate slope close to land, followed by a steeper slope lakeward. A gently sloping bottom, followed by a moderately sloping and steeply sloping bottom, characterize the nearshore area west of Oswego. The nearshore slope of the eastern shoreline is gentle and becomes moderate lakeward.

The sediment which is less than 3 inches in diameter represents the majority of littoral drift material. Samples were collected at each beach profiling location and the percentages of gravel (<1o), sand (-1o to 4o), and silt and clay (>4o) in the sample were determined.

Four sediment classes - gravel, sandy gravel, gravelly sand, and sand - describe the beach sediments of Lake Ontario. The only extensive beaches with sand are located at the eastern shoreline, at the Rochester embayment, and near the mouth of Sodus Bay. A majority of the beaches are composed of gravel-size material. Lithologically, sandstone and shale gravels dominate the beach sediments of the southern and eastern shoreline of Lake Ontario. Limestone gravels dominate the beach sediments north of Stony Point. Glacially transported crystalline gravels exceed 50 percent of the total gravel in the area between Reach Nos. 26 and 38.

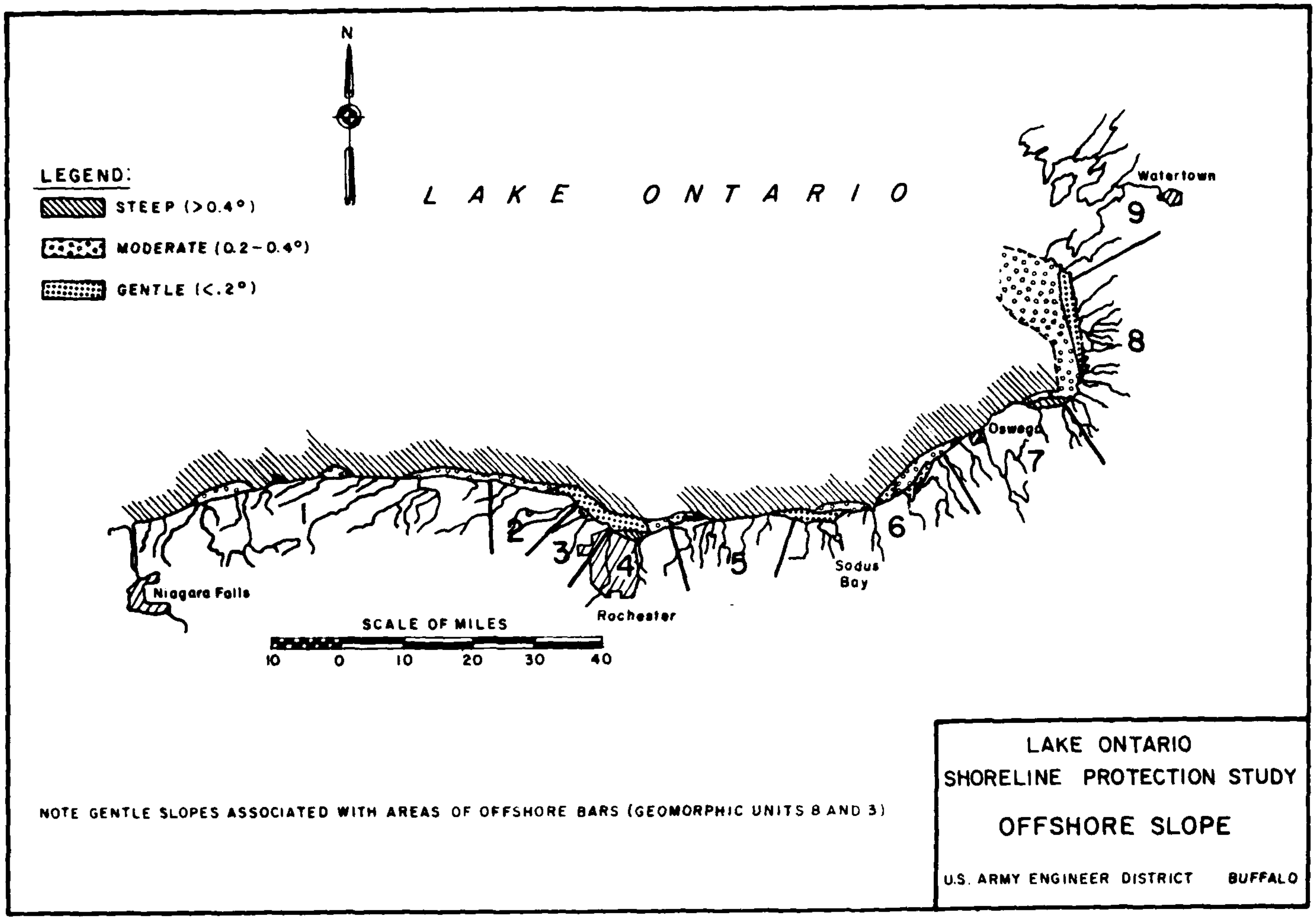

LEGEND:
STEEP (>0.4°)
MODERATE (0.2–0.4°)
GENTLE (<.2°)
N
LAKE ONTARIO
Watertown
9
8
Oswego
7
6
Sodus Bay
5
4
3
2
1
Rochester
Niagara Falls
SCALE OF MILES
10 0 10 20 30 40
NOTE GENTLE SLOPES ASSOCIATED WITH AREAS OF OFFSHORE BARS (GEOMORPHIC UNITS 8 AND 3)
LAKE ONTARIO
SHORELINE PROTECTION STUDY
OFFSHORE SLOPE
U.S. ARMY ENGINEER DISTRICT BUFFALO

Figure 2.7

The nearshore area, except at the eastern shoreline and off Rochester, is occupied by glacial boulders and bedrock occasionally covered with a thin sandy layer. The sand-sized material includes five sediment classes: sand, silty sand, clayey sand, clayey silt, and sand-silt-clay (nomenclature from Shepard, 1954). The grain size decreases toward offshore. Nearshore bottom sediments of the eastern shoreline and offshore of Rochester are sandy (Figure 2.8).

2.4 COASTAL PROCESSES

The erosion and flooding situation along a given reach of shore is controlled by lake level, wave action, shore and offshore topography and geology, current patterns, availability of beach-building material, and the activities of man.

Lake levels vary from season-to-season and year-to-year in response to variations in the climate which control the inflows. Generally, spring water levels are the highest with a gradual lake level drop through the summer and fall to the lowest levels in the winter months. Long-term climatic variations cause periodic lake level cycles. For example, there was low water in the late 1930's, high water in the early 1950's, low water through the mid-1960's, and high water in the mid-1970's. Beyond these periodic variations in the quantity of water in the basin, there can occur oscillations in the water surface induced by barometric pressure changes or long-term high velocity winds. These wind setups or seiche effects will "pile" water up toward one end of the lake causing an instantaneous short-term rise. The long-term monthly mean lake level will cause periodic changes in the shore erosion rate, however, it is the instantaneous setup which often causes inland flooding and disastrous property damage.

As the outfall for Lake Ontario (the St. Lawrence River) can be controlled, it is possible to influence the monthly mean lake levels. The presently implemented International Regulation Plan, 1958 D, has influenced the monthly mean lake levels by reducing the high lake level extremes, thus reducing the deviation from the average hydrograph. No regulation plan can control the instantaneous setups.

The Corps of Engineers, Detroit District, has prepared a report on Open-Coast Flood Levels for the Federal Insurance Administration (1977). This report presents the frequency of a combination high lake level with instantaneous setup for various sections of coast (Figure 2.9).

Significant wave action on Lake Ontario is generated by winds blowing across the water's surface. The strength and duration of the winds and the water fetch (or length of open water over which the winds can blow without obstructions) control the deep water wave height. As these waves approach shore, the wave base feels the shallowing lake bottom and the wave begins to shoal and eventually break. Design deep water waves have been computed by Resio and Vincent (1976) in Waterway Experiment Station Technical Report H-76-1, Report 2, for three general directional sectors at 17 Grid Points along the U. S. Lake Ontario Shore. The size of the design wave at any point along the nearshore will be controlled by the water depth.

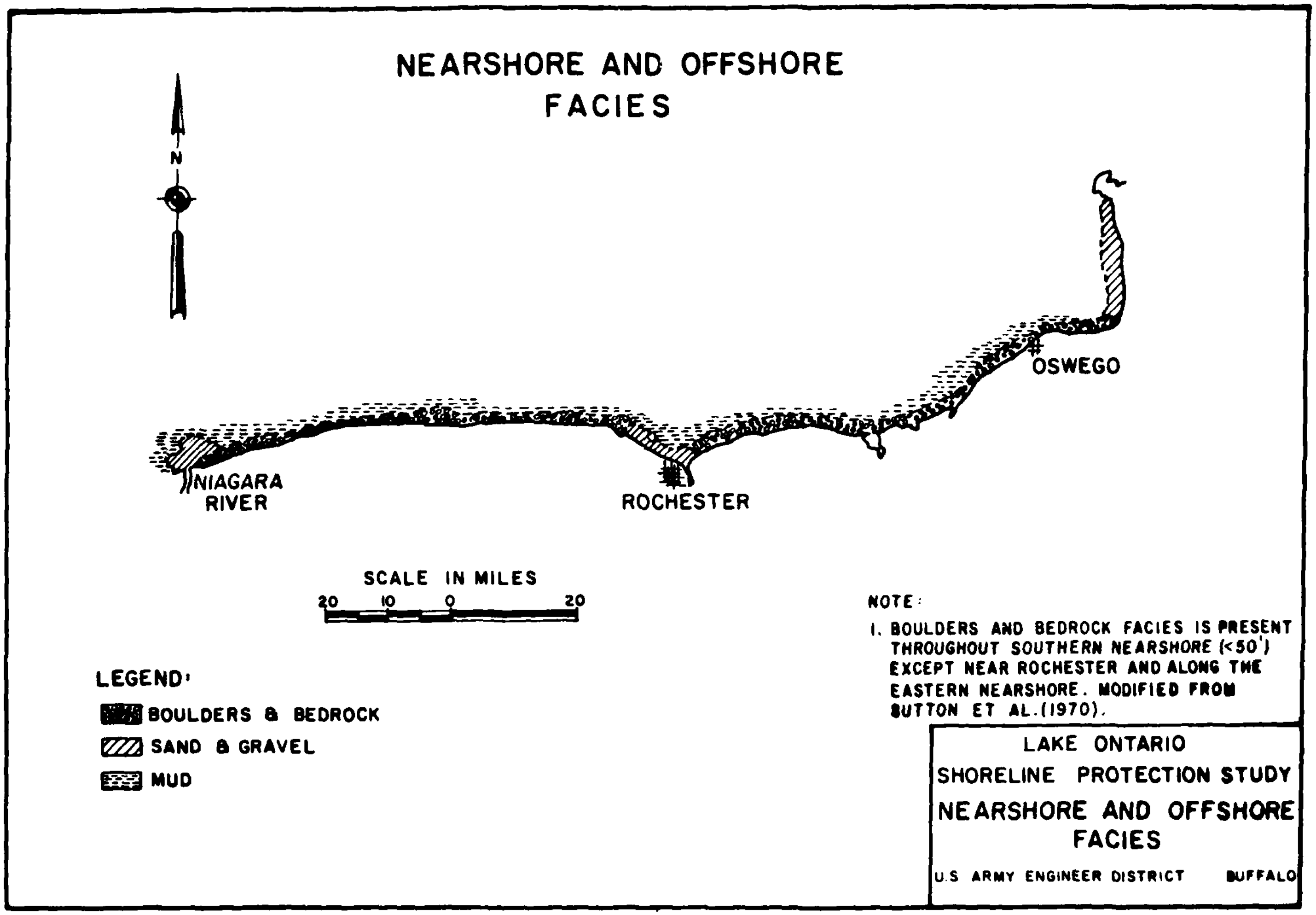
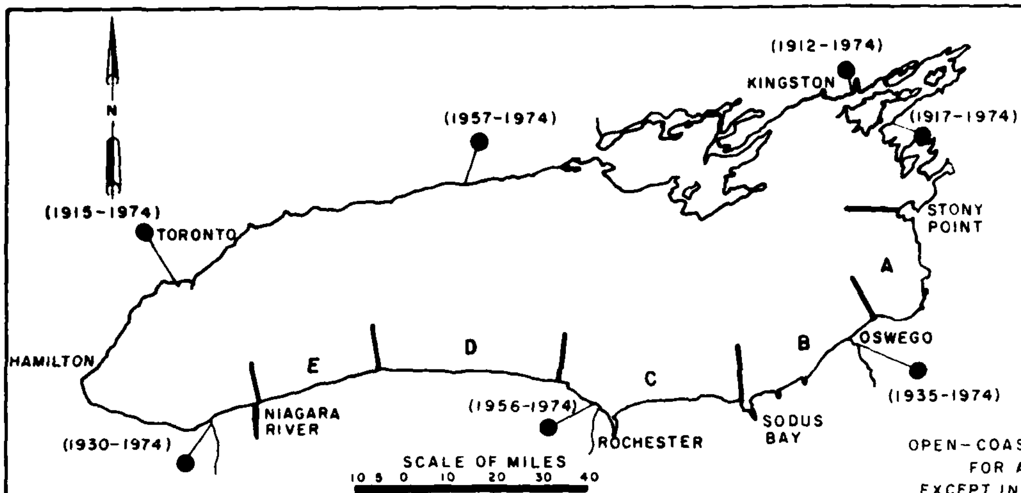

NEARSHORE AND OFFSHORE
FACIES
N
NIAGARA
RIVER
ROCHESTER
OSWEGO
SCALE IN MILES
20 10 0 20
LEGEND:
BOULDERS & BEDROCK
SAND & GRAVEL
MUD
NOTE:
1. BOULDERS AND BEDROCK FACIES IS PRESENT THROUGHOUT SOUTHERN NEARSHORE (<50') EXCEPT NEAR ROCHESTER AND ALONG THE EASTERN NEARSHORE. MODIFIED FROM SUTTON ET AL.(1970).
LAKE ONTARIO
SHORELINE PROTECTION STUDY
NEARSHORE AND OFFSHORE
FACIES
U.S. ARMY ENGINEER DISTRICT BUFFALO

Figure 2.8



LEGEND

● _Water level gaging station
(1935 1974) PERIOD OF RECORD

OPEN-COAST FLOOD LEVELS ARE APPLICABLE
FOR ALL LAKE ONTARIO SHORELINES
EXCEPT IN THE FOLLOWING PHASE II AREAS

AREA NORTH OF REACH A
REACH B — LITTLE SODUS BAY
REACH C — SODUS BAY
REACH C — IRONDEQUOIT BAY

Elevations shown for the indicated reaches represent the highest water levels along the open coast that on the average will have a 10 percent (10-year), 2 percent (50-year), 1 percent (100-year), or 0.2 percent (500-year) chance of being equalled or exceeded in any given year. These levels are based on frequency curves derived from the maximum instantaneous levels recorded each year adjusted to present diversion and outlet conditions at federal government water level gaging stations in Canada and the United States. The water levels along shorelines behind islands and in bays and estuaries may vary considerably from the open-coast levels.

LAKE ONTARIO TABLE

REACH	OPEN-COAST FLOOD LEVELS AT VARIOUS RETURN PERIODS *							
	10-YEAR		50-YEAR		100-YEAR		500-YEAR	
	IGLD	MSL	IGLD	MSL	IGLD	MSL	IGLD	MSL
A	247.5	248.7	248.0	249.2	248.2	249.4	248.6	249.8
B	247.4	248.6	247.9	249.1	248.1	249.3	248.5	249.7
C	247.3	248.5	247.8	249.0	248.0	249.2	248.4	249.6
D	247.2	248.4	247.7	248.9	247.9	249.1	248.3	249.5
E	247.1	248.2	247.6	248.7	247.8	248.9	248.2	249.3

* ELEVATIONS IN FEET IGLD (1955) AND MEAN SEA LEVEL OF 1929

LAKE ONTARIO
SHORELINE PROTECTION STUDY
OPEN-COAST
FLOOD LEVELS

U.S. ARMY ENGINEER DISTRICT BUFFALO

Figure 2.9

The direction of littoral transport is dependent upon the dominate wind patterns. Lake Ontario is within the prevailing westerlies, thus generated littoral currents are generally from west to east. The winds having maximum impact in generating high waves are associated with low-pressure centers which move eastward along a track located north of the lake. The fetch of the eastern shoreline and the eastern section of the southern shoreline is longest and receives the maximum wave energy (Figure 2.10). The frequency of occurrence of waves of different height (Figure 2.11) indicates that the significant wave-approach direction for the eastern shore is from west and west-southwest. At Rochester, however, waves from northeastern quadrants contribute significantly to the littoral process. The western section of the south shore of Lake Ontario receives maximum waves and wave energy from a northeast direction. The easterly wind is generated when the lake is in the navigable semicircle or in the safest quadrant of the cyclone track (Williams et al., 1968). As a consequence, the waves generated by easterly winds are lower and western shorelines receive less energy. Variations exist due to local irregularities in the shoreline and, of course, reversals due to individual storms are frequent. Embayments, such as Irondequoit Bay and Mexico Bay, are characterized by a local point of convergence where no longshore direction of transport dominates. Offshore transport of sediment frequently occurs at river mouths, stick-out features, and headlands. Onshore transport is rare except at the east end of Lake Ontario where long period swells transect a broad shallow offshore sand sheet.

The predominant waves during the ice-free period (1 March through 31 December) are less than 2 feet high. Waves higher than 6 feet are more common at the eastern shoreline. High deep water waves may form during winter storms; but the influence of such waves on littoral processes is insignificant as ice formation on the shore virtually ceases any longshore transport. The longshore component of wave energy flux which is responsible for longshore sediment transport (drift) varies extensively along the shoreline. A qualitative determination of the drift rate reveals that it ranges from weak to moderately strong. The drift pattern at the eastern shoreline is from south to north toward the southern end from north to south toward the northern end with a poorly defined nodal point in the general vicinity of the North Pond barrier. The drift direction along the southern shoreline is predominantly from west to east, but occasional drift reversal is observed. Three drift divides located at Reach Nos. 26, 83, and 90 are observed.

The topography and geology of the shore and nearshore control the wave energy reaching the shore and the availability of beach-building materials. A shallow offshore area will greatly reduce the wave energy at the shore as the approaching waves break offshore. The presence of an offshore sand source, a river delta, or sand and gravel rich bluff material will supply sediment to the beach. In Lake Ontario there are offshore sand sheets, at the mouth of the Niagara River, near Rochester between Braddock Bay and Irondequoit Bay, and in Mexico Bay. Major rivers such as the Niagara, Genesee, and Oswego, carry sands and gravels, but in the case of the latter two rivers, much of this material deposits inside the dredged harbor. The bluff material along the southern shore of Lake Ontario is largely sand and gravel deficient glacial tills or lacustrine silts and clays. There are a few specific bluff areas where the bluff material is composed of sand and gravel rich glacial outwash or kame deposits. In general, the quantity of beach-building

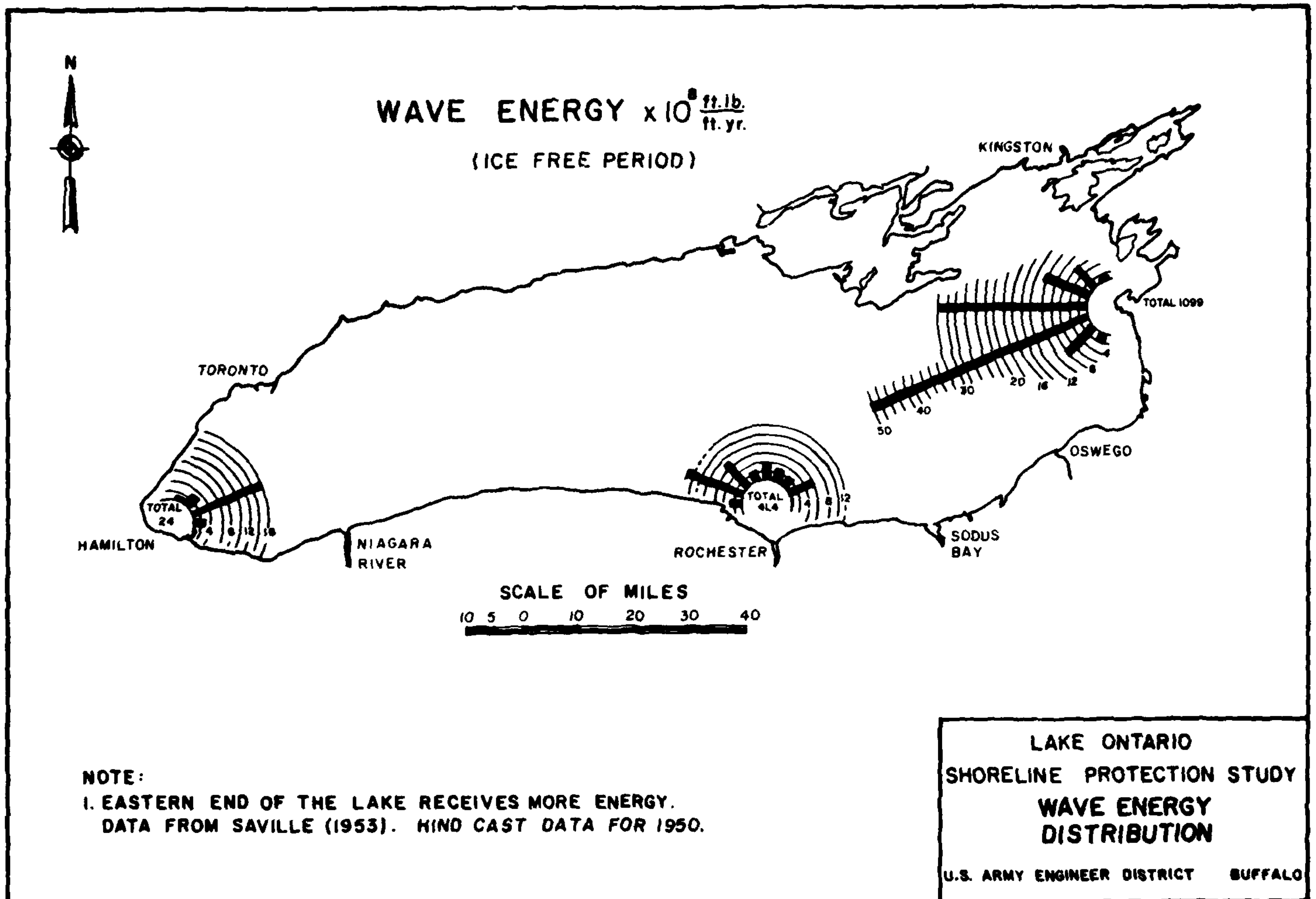
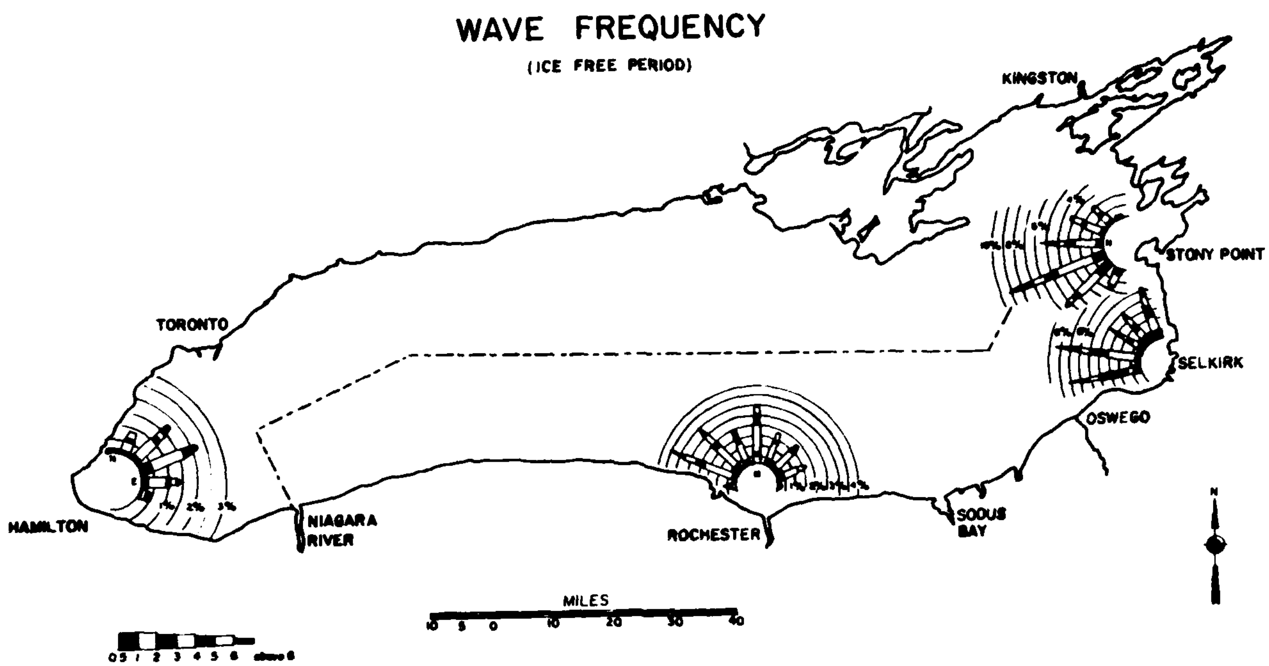

N
WAVE ENERGY x $10^8 \frac{ft.lb.}{ft.yr.}$
(ICE FREE PERIOD)
KINGSTON
TOTAL 1099
TORONTO
TOTAL 24
HAMILTON
NIAGARA RIVER
TOTAL 414
ROCHESTER
SODUS BAY
OSWEGO
SCALE OF MILES
10 5 0 10 20 30 40
NOTE:
1. EASTERN END OF THE LAKE RECEIVES MORE ENERGY.
DATA FROM SAVILLE (1953). HIND CAST DATA FOR 1950.
LAKE ONTARIO
SHORELINE PROTECTION STUDY
WAVE ENERGY DISTRIBUTION
U.S. ARMY ENGINEER DISTRICT BUFFALO

Figure 2.10



NOTE:
WAVE FREQUENCY DIAGRAMS FOR LAKE ONTARIO DATA FROM SAVILLE (1953) AND COHN (1973). NOTE THE PREDOMINANT WAVE APPROACH FROM WEST TO SOUTHWEST AT STONY POINT. SELKIRK RECIEVES SIGNIFICANT WAVES FROM THE NORTHWESTERN QUADRANT ALSO. WAVE HEIGHT SCALE IS IN FEET.

LAKE ONTARIO
SHORELINE PROTECTION STUDY
WAVE FREQUENCY
DISTRIBUTION
U.S. ARMY ENGINEER DISTRICT BUFFALO

Figure 2.11

material available to the nearshore is limited. During Stage 2 of this study, a sediment budget will be prepared to quantitatively evaluate the present sources and sinks of beach material and predict the effects of any alternative study recommendations.

The activities of man have influenced the coastal processes along many sections of shore. Groins and jetties block littoral transport causing updrift deposition and downdrift starvation while promoting offshore losses. Vertical revetments frequently reflect wave energy offshore, causing scour and offshore losses. Other revetments which protect areas of bluff from recession may not cause overt damage, but they do upset the sediment budget by eliminating sections of bluff as sources of sand and gravel. Any construction plan or operation practice which eliminates sediment sources or promotes sediment losses to the offshore will enhance erosion. Any construction which manipulates the nearshore wave or current pattern may redistribute the erosion-deposition character of the shore.

2.5 THE SHORELINE

2.5.1 GENERAL

The total shoreline of the Great Lakes, including mainland and islands in the U. S. and Canada, as determined by the International Great Lakes Levels Board, is approximately 10,580 miles. The measure of shoreline length, more so than other physical parameters, is highly dependent on the scale of the maps used for measurement. This is due to the loss of definition of small irregularities with a decrease in the scale of the map.

The physical characteristics of the United States shore of the Great Lakes are the results of development of the Great Lakes Region since the recession of the ice sheet. They range from high bluffs of clay, shale, and rock, through lower rocky shores and sandy beaches, to low, marshy clay flats. Except where bedrock is exposed or protective works have been constructed, the glacial overburden comprising much of the shore of the Great Lakes is still vulnerable to shore erosion.

Erosion and flooding problems are caused by the forces of nature and the characteristics of the shoreline area subjected to these forces.

The first major cause of the problems, the forces of nature, involves storms, lake levels, wave action, frost and ice action, underground water seepage, and surface water runoff. Major storms create the largest changes in the shore. The direction, magnitude, duration of storms, and the fetch length determine wave heights and littoral currents.

The duration of a storm is an important consideration. If a storm persists, waves can build up to great heights and may be superimposed upon high lake levels. Fetch can account for major variations in wave intensity. Of the forces which create large waves, fetch when combined with a strong wind

of long duration, is probably the most important. When high lake levels are coincident with the other forces of nature cited here, they can greatly magnify total effects.

Levels of the Great Lakes fluctuate from year to year as well as from month to month. These fluctuations depend upon the volume of water entering and leaving the lakes. In addition, there are daily and even hourly fluctuations, known as seiches that result from a tilting of the lake surface by winds and barometric pressure differences. Seiches are generally more pronounced on Lake Erie because it is shallow and its longitudinal axis is west-southwest.

Wave action works directly on the beach or at the toe of the bank, eroding clay, silt, sand, and gravel. This erosion is increased when lake levels rise, because the beaches are narrower or submerged, and the waves are able to attack the unprotected toe of the banks or bluffs directly. Thus, a wide beach is the best protection the upland shore can have from wave attack.

Seepage often comes through sandy layers in glacial till bluffs. When underground water seeps out of exposed bluffs of unstable, or loose material, it causes slumping and further weakens the material. This often results in large slides. Sometimes, man-made drainage works cause problems with underground water.

Often the most severe threat to the shore is erosion by frost and ice. In certain of the fine-grained silty soils along the lakes, the alternate freezing and thawing can weaken the soil and cause it to slide. Frost and ice formation in fissures in clays, glacial tills, or shale bluffs may contribute to their erosion. Shore ice is another cause of damage when broken up and driven onto the beaches by onshore storms. Lake bottom material may be scoured out and structures are often damaged. However, shore ice can be of benefit too. It protects the shore from erosion by winter storms.

Surface water runoff carries with it large amounts of erodible material, particularly where there are barren, steep-sloped bluffs. Where the surface is carried off by man-made drainage works, inadequate protection of the sewer outfall may cause increased erosion at that point.

A second major factor influencing erosion lies in the characteristics of the shoreline upon which the forces of nature impact. The principal characteristics here include the orientation, resiliency, and human value of the shoreline.

An unfavorable orientation can magnify lake levels and wave intensity. Winds, particularly of storm velocity, and sharp gradients in barometric pressures over short distances can cause a wide range of fluctuation in lake levels. When short-period fluctuations are superimposed on above-average levels, they may cause unusually high water levels. High storm levels at one end of a lake are accompanied by lower levels at the opposite end. Pronounced fluctuations from these causes are also experienced in bays and other shallow portions of each lake.

The resiliency of the coastline to water dynamics depends upon the material of which the shorefront is composed. In order of progressively diminishing resiliency in their ability to withstand wave forces are the rocky coasts of Minnesota, the sandy beaches of Indiana, and the silty-clay bluffs of Ohio.

Beaches are energy dissipators. Their efficiency in this role is greatly influenced by their profile. The nearer deep water is to the shore, the closer large waves can approach before their energy begins to dissipate because of bottom drag. The flatter the gradient both offshore and on the beach "run up" area, the longer and more gradual is this dissipation. A narrow, steep beach will be subject to much greater wave forces than a flatter beach. An offshore bar, breakwater, or island will dissipate waves affording protection within the areas they shelter.

Based on the National Shoreline Study, Volume V (1973), House Document No. 93-121, the total shoreline of the Great Lakes is about a third residential, one-half agriculture, forest and undeveloped, 10 percent recreation (public), and 7 percent commercial-industrial and public buildings. Only 17 percent of the Great Lakes shoreline is publicly owned. In all of these locations, the water is gaining at the expense of the land-part of the geologic process. A third of the Great Lakes shoreline is subject to significant erosion. Over the last 125 years, the average annual rate of loss in many locations has been from 1 to 5 feet.

2.5.2 LAKE ONTARIO SHORELINE

The following discussion of the Shoreline Inventory Data presents the baseline condition for each reach. This information will be updated during later phases of this study into a systematic comparison by reach, township, and county. For the present reconnaissance level study, the following discussion was extracted from the National Shoreline Study, Volume V (1973), House Document No. 93-121.

a. Niagara County. The Lake Ontario Shoreline of Niagara County is essentially straight, extending for about 31 miles in an east-northeast direction from the mouth of the Niagara River. It includes Reaches 1 through 15 of the Lake Ontario Shoreline Protection Study. The shore bluffs are from 30 to 60 feet high. For the most part, they are composed of glacial deposits consisting of till of various forms and layered drift and sheets of outwash sand and gravel. The bluffs are open to wave attack, frost action, seepage, and surface erosion. Only a small amount of residual material from erosion of the bluff is coarse enough to remain in the beach zone. This accounts, in part, for the lack of wide beaches on the south shore of Lake Ontario in this county. The Queenston Formation bedrock rises from about 10 feet below lake level, just east of the mouth of the Niagara River, to about 25 feet above lake level at Thirty-Mile Point, near the east county line. Rock outcrops occur above lake level just east of Olcott Harbor.

The westerly 20 miles of shore, from the Niagara River to a mile out of Olcott Harbor, are quite generally developed, with a fringe of summer and permanent residences along the lakeshore. The upland is agricultural land.

Between Olcott and the Niagara-Orleans County Line, residential developments are more widely scattered, and the shore is generally in agricultural use or undeveloped. During the past 20 years, the main change in shore use has been marked increase in residential use and park development, with a similar decrease mainly in agricultural use.

There are four State parks in Niagara County, with a shoreline frontage of about 3.75 miles. Local parks and other public and semipublic developments have a frontage of about 2.3 miles. All of the State park lands have been obtained within the past 12 years to meet the long-range needs for public open-space and recreational areas. The four State parks are Fort Niagara, Four-Mile Creek, Tuscarora Park near Wilson, and Golden Hill State Park, between Thirty-Mile Point and the Niagara-Orleans County Line. All are in the early stages of development by the State.

Federal projects provide small-boat harbors at Wilson and Olcott Harbors. Both have private marina and yacht club facilities. There are also private marinas and a launching ramp in the lower Niagara River at Youngstown. There is a small public marina and launching ramp at Golden Hill State Park. Preliminary studies of proposed Federal small-boat harbors at Four-Mile Creek and Golden Hill State Parks have been made.

The loose bluff material of Niagara County is very open to erosion. A beach erosion study made about 40 years ago reported that in the 64-year period between 1875 and 1939, the highest rate of erosion, which occurred around Wilson Harbor, was nearly 5 feet per year. The erosion did not occur at a uniform rate and was accelerated during periods of high lake levels. Erosion rates in the easterly half of the county were much slower. However, it was found necessary to protect the lighthouse at Thirty-Mile Point with heavy stone revetment. This was done because of deterioration and erosion of the shale outcrop at the lakeshore, which at this point appears as high and as strong as at any point in the county.

During the record high water levels that occurred in 1952, there was flooding of some of the commercial fishing docks at Wilson Harbor and of other low docks and land areas in Wilson and Olcott Harbors.

Significant erosion of the bluffs, particularly just west of Wilson, occurred during the 1951-52 and 1972-73 high water periods.

Lake Erie established new high monthly mean levels in 1972 and 1973 with all months exceeding the 1952 highs for these months. However, the levels of Lake Ontario were below the 1952 levels. The physical extent of erosion and flooding was, therefore, less during 1973 when compared to those on the Upper Lakes. One reason for this is that since April 1960, following completion of the St. Lawrence Seaway, the levels of Lake Ontario have been regulated by controlling outflows through the St. Lawrence River. The Regulation Plan, approved by the International Joint Commission, allows the peak level of the lake to be lowered about 1 foot below the highest level it reached under the most severe conditions in the past.

Over 5 miles of the Niagara County shoreline is protected. About 0.8 of a mile is stone revetment along the highway east of Wilson. Most of the protective structures are stone revetment or concrete seawalls. Groins have been constructed in a few places, at Krull Park for instance, just east of Olcott. Because of the scarcity of littoral drift, little accumulation of sand has occurred. The widest existing beaches are west of Wilson Harbor and Olcott Harbor where the long entrance jetties, in place for many years, have encouraged accretion of sand and gravel beaches.

b. Orleans and Monroe Counties. The shorelines of Orleans (Reach Nos. 16 through 25) and Monroe (Reach Nos. 26 through 50) Counties have a combined frontage of 59 miles. This extends from the Niagara County Line near Thirty-Mile Point, to the Wayne County Line, located about 12 miles east of Rochester Harbor. The shore characteristics vary considerably, from the 20-foot or higher glacial till bluffs of Orleans County to the low marshy shore that generally extends across Monroe County, except the west end, between the Orleans County Line and Hamlin Beach State Park, and at the east end, between Rochester Harbor and the Wayne County Line. About 20 miles of the Monroe County shore west of Rochester is low marshland with barrier sand and gravel beaches separating the marshes and open ponds from Lake Ontario. The easterly 7 miles of the Monroe County shore through the town of Webster has silt and clay bluffs up to 55 feet high.

The beaches along the shore of both counties are too narrow to provide much protection. There is generally a narrow sand or gravel beach perhaps up to 30 feet wide but no wide beaches, except where held by major structures such as the U. S. West Pier at Rochester Harbor. There is considerable sand in some of the bluffs, notably at Devils Nose in Hamlin Beach State Park. The bluffs are eroding over the entire length of Orleans County, where unprotected. Monroe County, which is more highly developed, has more of its shore protected.

The shore of Orleans County has a fringe of residential development along a little over half of its total frontage. The remainder is mostly open space, i.e., agricultural, undeveloped, or parkland. Twenty miles of Monroe County is in residential use, about 7 miles is parkland, and the remainder is undeveloped or used for commercial and industrial purposes. Within the past 20 years, there has been a reduction in agricultural and undeveloped property and a marked increase in residential and park properties.

In 1964, the State of New York acquired some 1.5 miles of frontage in Orleans County, just to the east of Johnson Creek, as part of Lakeside State Park. The park frontage is a high bluff and is not improved or protected at the present time. Hamlin Beach State Park in Monroe County is an older park and has a frontage of about 3 miles that is partly protected and improved by a Federal and State Cooperative Beach Erosion Control Project. The other main public parks in Monroe County are: Ontario Beach Park, just west of the U. S. West Pier at Rochester Harbor, owned by the city of Rochester; Durand Eastman Park, between Rochester Harbor and Irondequoit Bay, owned by the city of Rochester but leased to Monroe County; and Webster Park, a county park about 4 miles east of Irondequoit Bay.

There is a deep-draft navigation harbor at Rochester along with public and private marina facilities. A Federal harbor-of-refuge has been constructed at Oak Orchard, and authorized for study for Hamlin Beach State Park and Irondequoit Bay. Public and/or private marina facilities are also available at Braddock Bay, Sandy Creek, and Johnson Creek.

The marshy frontage of Monroe County is a valuable wildlife resource. The ponds and marshes provide a habitat for muskrats, mink, and ducks, as well as spawning areas for game fish.

The shores of these two counties suffered significant erosion and flood damage during 1951-52 and 1972-73. Properties along the low shore between Hamlin Beach State Park and Rochester Harbor were the most heavily damaged. Summer homes and permanent residences on the barrier beaches were flooded for several months, and many suffered from wave action and erosion.

During the 1973 high water levels that affected the Upper Lakes, Lake Ontario suffered less damage because of lake regulation made possible by construction of the St. Lawrence Seaway. Levels of Lake Ontario were less than the 1951-1952 average levels.

The existing protection provided by private property owners in Orleans and Monroe Counties is mostly stone revetment or concrete seawalls. Groins have been built at Hamlin Beach State Park and Braddock Bay State Park to improve the recreational bathing beaches.

c. Wayne, Cayuga, and Oswego Counties. The total length of the shoreline of Wayne (Reach Nos. 51 through 78), Cayuga (Reach Nos. 79 through 84), and Oswego (Reach Nos. 85 through 94) Counties is about 78.9 miles. The latter county line ends approximately at the extreme east end of Lake Ontario about 7 miles north of the mouth of the Salmon River at Port Ontario. The major drainage areas are the Oswego River Basin and the Wayne-Cayuga Complex. The communities located along the shoreline are Pultneyville, Sodus Point, Fair Haven, and Oswego.

The westerly 22 miles of the Wayne County shore, between the Monroe-Wayne County Line and Sodus Bay, have a quite continuous bluff from 10 to 70 feet high, with an average height of about 25 feet. The bluff material is mainly silt and clay. The average width of the beach is about 10 feet. The beach material is coarse gravel and shingle. Ledge rock is generally at, or up to 3 feet above, lake level.

The easterly 15 miles of the Wayne County shore, between Sodus Bay and Little Sodus Bay, are a series of drumlins (elongated hills of glacial till) separated by marshes that extend several miles inland along small creeks that enter the lake. The drumlins are up to 150 feet above lake level and one-quarter to one-half mile wide at their base. The material at the bluff face of the eroding drumlins is glacial till, containing from about 10 to 100 percent sand and gravel. Lake Bluff, just east of Sodus Bay, and Chimney Bluff, 2 miles farther east, are two of the highest. The latter is undeveloped and is in State park property. Beaches at the base of the drumlins are

generally less than 10 feet wide. Narrow sand and gravel barrier beaches have formed across the low marsh areas or open water between the drumlins.

The shore characteristics of the entire 8 miles of the Cayuga County shore, and the westerly 5 miles of Oswego County to the west city line of Oswego are similar to those in eastern Wayne County.

For about 13 miles east of the mouth of the Oswego River, the shore bluffs are from 5 to 25 feet high. Rock outcrops from lake level to 10 feet or more above lake level occur within this reach. The overlying material is glacial till. Gravel and shingle beaches up to 30 feet wide also occur. From 13 miles east of Oswego to the Salmon River at Port Ontario, the shore contains occasional reaches of high ground separated by marsh areas that are fronted by barrier beaches. These beaches are similar to but less prominent and noticeable than the drumlin formations farther to the west.

The remaining Oswego County shoreline north of the Salmon River is generally a barrier beach with sand dunes up to 45 feet high, separating either marsh areas or open ponds from the lake. The dunes and wide flat beaches consist of fine sand.

The upland shore of Wayne County is used mainly for agricultural purposes. Fruit is the principal crop. A fringe of scattered residential developments borders the lakeshore. Chimney Bluffs State Park, just east of Sodus Bay, has a frontage of nearly 2 miles.

In the last 20 years, there has been an increase in industrial use, due to the construction of an aluminum plant and nuclear power production facilities near Oswego. As in other parts of the south shore of Lake Ontario, residential and park use has also increased. Agricultural and undeveloped land use has decreased a like amount.

There is a State park in each of the three counties: Chimney Bluff State Park in Wayne County, Fair Haven State Park in Cayuga County, and Selkirk Shores State Park in Oswego County. County and town parks and other semi-public areas provide additional public access to the shore.

There are Federal deep-draft harbors at Great Sodus and Oswego Harbors. There is an existing Federal small-boat harbor at Fair Haven that provides an entrance to Little Sodus Bay, and authorized but unconstructed projects at Port Bay and Port Ontario. There are existing private marina or yacht club facilities at Pultneyville, Fairbanks Point, and North Pond. There is a launching ramp at Mexico Bay, at the mouth of Little Salmon River, where the State of New York is considering further improvements. A study of a proposed Federal small-boat harbor at this location has been authorized.

A relatively large part of the frontage of Cayuga and Oswego Counties is of particular interest as wildlife habitat because of large marsh areas and protected ponds along the shore.

The shore of these three counties is subject to significant erosion where unprotected, except for a few short reaches where bedrock rises high enough above lake level to armor the toe of the bluff against wave attack.

During the 1951-52 period of high lake levels, residential property at Mexico Point and State park property in Selkirk Shores State Park were critically eroded. Afterwards, over 4,500 feet of park frontage were protected under a Federal cooperative project. This project protected Selkirk Shores during the 1972-73 high water.

Significant flooding of low areas, particularly in Sodus Bay and around other bays, ponds, and barrier beaches, also occurred in 1951-52 and 1972-73.

General information on rates of erosion throughout this three-county area is not available. Studies made at Fair Haven Beach State Park and Selkirk Shores State Park showed that at Fair Haven the average rate of erosion of the high bluff had been 4 feet per year between 1938 and 1952. The lower, 10-foot high bluff had eroded at a rate of 10 feet per year. At Selkirk Shores State Park, 40 feet of the bluff were lost following failure of a concrete crib seawall in 1952.

The regulation of Lake Ontario levels, in effect since 1960, following completion of the St. Lawrence Seaway, has reduced erosion and flood damage. In 1972-73 when record or near-record high levels occurred in the Upper Lakes, the levels of Lake Ontario were less than 1952 levels.

About 0.8 of a mile of shore in Wayne County is protected, generally by seawalls or revetment; 0.4 of a mile is protected in Cayuga County; and 2.5 miles are protected in Oswego County. This includes 1.4 miles behind the breakwaters at Oswego Harbor.

d. Jefferson County. The shore of Jefferson County, between the Oswego-Jefferson County line, 7 miles north of the mouth of the Salmon River at Port Ontario, and Tibbett's Point at the head of the St. Lawrence River, is very uneven and contains several deep bays and prominent headlands. The total length of the shore is about 120 miles. For 10 miles north from the Oswego County line, a barrier beach and sand dune extend in nearly a straight line, separating marsh areas and small ponds from the open lake. The beach and dune are composed of very fine sand, and the beach has a very flat offshore slope and is relatively stable. At the end of this 10-mile reach, the shore characteristics change abruptly. Rock outcrops at the water's edge and rises gradually to a height of about 75 feet on the west side of Stony Point. It then falls gradually, as the shore continues around Stony Point into Henderson Bay. From Henderson Bay to the head of the St. Lawrence at Tibbett's Point, there is generally shale or limestone rock for several feet above lake level. The rock has a few feet of earth cover containing considerable granular material. There are a few pockets of sand beach, but the beach material is mostly gravel, shingle, or ledge rock. Marsh areas occur at the inner end of some of the deep bays.

About 3 of the 10 miles of barrier beach and dunes north of the Oswego County Line have been developed for summer residential use. Much of the

remaining shore in the county has occasional reaches of residential development, when accessible by roads. The principal change in the last 20 years is a large increase in residential development, with a similar decrease in agricultural and undeveloped frontage.

There are no deep-draft navigation harbors in Jefferson County. An oil terminal using an offshore mooring and pipeline to shore is the principal commercial navigation facility. The only Federal project along the lakeshore of the county is a light-draft harbor at Sackets Harbor. Private marina facilities are available at nine locations, three of which have launching ramps. There are two other launching ramps at State parks, one at Westcott State Park on Henderson Bay, and another at Long Point State Park, which is in Chaumont Bay. A third State park in Jefferson County is Southwick Beach State Park, located near the northerly end of the dune area, about 5 miles north of the Oswego-Jefferson County Line. The interest in boating and development of summer homes in this area are due in large measure to excellent fishing in the vicinity. The relatively protected bays offer shelter to small boats and permit their use at times when open-lake use is hazardous.

In spite of the rocky shore around most of the shoreline, there was significant erosion damage during the record levels of 1952. Highways bordering the lakeshore had to be protected by revetment. Many cottages and homes close to the shore also required protection. Damage was scattered throughout the area, rather than concentrated in any particular reach. Due to regulation of the levels of Lake Ontario, in effect since 1960 under authority of the International Joint Commission, the lake levels in 1972 and 1973 were less than 1952 levels.

2.6 CLIMATE

The Great Lakes region, as well as Lake Ontario, specifically, has a climatic regime which includes four distinct seasons, a variety of precipitation types and sources with stable month-to-month quantities, and the influence of the water bodies themselves in modifying continental air masses. In winter, arctic air results in mean daily temperatures below freezing for 1 or 2 months. From June through October, remnants of hurricane systems may pass close to or into the Lake Ontario basin, producing heavy rains and winds.

2.6.1 AIR TEMPERATURES

Table 2.4 shows average monthly air temperatures at perimeter stations in the Great Lakes and the Lake Ontario watershed. The mean annual temperature for Lake Ontario perimeter stations is 47°F for the period 1931-1969.

Table 2.4 - Average Perimeter Air Temperature for the Great Lakes, 1931-1969 (Degrees Centigrade)

Period	Lake: Superior	Michigan	Huron	Erie	Ontario
January	-11.2	- 6.4	- 7.4	- 3.8	- 5.2
February	-10.4	- 5.6	- 8.0	- 3.7	- 5.2
March	- 4.7	- 0.4	- 3.5	0.9	- 0.1
April	3.1	6.8	4.1	7.4	6.8
May	9.2	12.7	10.2	13.6	13.1
June	14.6	18.4	15.8	19.2	18.7
July	18.1	21.3	18.9	21.8	21.4
August	17.4	20.4	18.7	20.9	20.3
September	13.0	16.4	14.2	17.2	16.4
October	7.2	10.3	8.7	11.1	10.2
November	- 0.7	2.8	2.0	4.3	3.8
December	- 7.7	- 3.6	- 4.2	- 1.7	- 2.8
Annual	4.0	7.8	5.8	8.9	8.1

Values are based on data for the following stations:
Superior: Sault Ste. Marie, Marquette, Duluth, and Thunder Bay.
Michigan: Milwaukee, Muskegon, and Green Bay.
Huron: Alpena, Gore Bay, and Wiarton.
Erie: Toledo, Cleveland, Buffalo, and London.
Ontario: Rochester, Syracuse, Trenton, and Toronto.

Source: Great Lakes Basin Framework Study, Appendix 4, GLBC, 1976.

2.6.2 WATER TEMPERATURES

Water temperatures in Lake Ontario have a range which is about half the range in air temperatures. The maximum and minimum water temperatures lag behind the corresponding air maxima and minima by about 1 month. Lake Ontario rarely freezes over completely. Thus, even in midwinter, while portions may be at 32°F, at the surface there is both longitudinal and vertical nonuniformity. Table 2.5 shows a comparison of Great Lakes water surface temperatures.

Table 2.5 - Comparison of Great Lakes Water Surface Temperature (Degrees Centrigrade)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Lake Superior													
Lake Survey (1944) 1904-43 [1]	0	0	0	1	3	4	8	12	11	8	5	1	4
Millar (1952) 1935-39	-	-	-	-	2	4	7	13	12	9	6	-	-
Richards & Irbe (1969) 1959-68	2	0	0	1	2	4	7	12	12	9	6	4	4
Lake Michigan													
Lake Survey (1944) 1904-43 [1]	0	0	1	4	7	12	17	18	16	11	7	2	8
Millar (1952) 1935-41	-	-	-	-	5	11	16	21	18	12	8	-	-
Lake Huron													
Lake Survey (1944) 1904-43 [1]	0	0	1	3	6	12	18	19	17	12	7	2	8
Millar (1952) 1935-41	-	-	-	-	4	9	18	20	16	12	7	-	-
Richards & Irbe (1969) 1959-68	3	2	1	1	4	8	15	18	16	12	8	6	8
Lake Erie													
Lake Survey (1944) 1904-43 [1]	0	0	3	6	9	18	22	22	21	14	7	1	10
Millar (1952) 1937-41	-	-	-	-	10	17	21	23	19	15	9	-	-
Richards & Irbe (1969) 1950-68	1	1	1	3	9	17	21	22	19	15	9	4	10
Lake Ontario													
Lake Survey (1944) 1904-43 [1]	0	0	2	5	9	14	18	19	17	13	7	1	9
Millar (1952) 1936-46	3	2	2	3	6	12	19	21	18	13	7	4	9
Richards & Irbe (1969) 1950-68	3	2	2	3	6	12	19	21	18	13	7	4	9

1 Period shown for Lake Survey study indicates extreme limits and not actual length of data.

Source: Great Lakes Basin Framework Study, Appendix 4, GLBC, 1976.

2.6.3 SOLAR RADIATION

The conversion of water from liquid or solid state to vapor, one of the main transfer processes of the hydrologic cycle, uses the energy from the sun. In an average year, the Great Lakes Basin receives energy through solar radiation at a rate of 330 langleys (gm.cal./sq. cm.) per day. The seasonal variation is closely related to the latitudinal length of day and elevation angle of the sun. The daily maximum is received in June (about 530 langleys) and the minimum in December (about 105 langleys).

Solar radiation has large local variations because of the presence of urban areas, which produce atmospheric turbidity. Near the lakes, more clouds are produced during the fall and winter, when water temperatures are higher than air temperatures, resulting in less solar radiation.

2.6.4 ATMOSPHERIC HUMIDITY

The measure of atmospheric humidity is vapor pressure. For a given month, it is relatively constant, with annual variation from about three millibars in January to about 17 millibars in July. Diurnal variations in vapor pressure are small. The higher afternoon temperatures increase evaporation and cause an increase in vapor pressure. Low temperatures toward dawn result in lower evaporation with lower vapor pressures, and often condensation occurs with lower vapor pressures at this time. In general, the vapor pressure has a north-south gradient over the Great Lakes basin with the lowest values to the north of Lake Superior and the highest values near the southern basin boundary. The pattern of vapor pressure over the lakes is influenced by the evaporation from and condensation on the lakes. The pressure is distorted over the lakes and on their lee shores, tending to increase in these areas as the season progresses from spring to fall.

2.6.5 PRECIPITATION

Precipitation in the form of rain, snow, and condensation is the source of all water (except diversions) which supplies the Great Lakes. The mean annual station precipitation across the Great Lakes Basin ranges from less than 28 inches northwest of Lake Superior to a maximum of 52 inches in the Adirondacks east of Lake Ontario. Table 2.6 gives precipitation for the Great Lakes individually.

Because of the vast size of the Great Lakes basin, the effects on Lake Ontario of precipitation depend on the location of the precipitation, which is not uniformly distributed spatially. Precipitation directly on the lake surface is obviously immediately felt, followed by that on the local drainage area, while precipitation on the lakes above Lake Ontario must pass through the tributary systems of those lakes, as well as through storage in the lakes themselves. Thus, the effects of Lake Superior basin precipitation does not reach Lake Ontario for several years.

One of the characteristics of the climate of the Great Lakes region is the small seasonal variation in precipitation. The area north and west of Lake Superior has a seasonal change from summer precipitation maximum to winter precipitation minimum averaging about 20 to 30 percent of the summer

Table 2.6 - Precipitation for Selected Months for the Great Lakes Basins 1931-1960 (Inches)

	January	April	July	October	Annual
ONTARIO					
Maximum	4.61	4.23	5.75	7.99	43.06
Minimum	1.22	1.29	1.28	0.77	27.58
Mean	2.17	2.63	3.10	2.93	34.50
Standard Deviation (Inches)	1.04	0.67	1.06	1.53	3.60
Coefficient of Variation (Percent)	48	24	34	52	10
ERIE					
Maximum	5.87	5.53	5.12	7.64	42.63
Minimum	1.06	0.93	1.53	0.80	24.88
Mean	2.54	3.14	3.06	2.64	33.80
Standard Deviation (Inches)	1.25	1.07	0.89	1.48	4.70
Coefficient of Variation (Percent)	49	34	29	56	14
HURON					
Maximum	3.99	3.94	4.46	6.04	39.03
Minimum	1.06	1.13	1.32	0.87	26.32
Mean	2.40	2.43	2.78	2.87	32.00
Standard Deviation (Inches)	0.61	0.75	0.71	1.36	3.20
Coefficient of Variation (Percent)	25	31	26	47	10
MICHIGAN					
Maximum	3.33	5.28	6.00	5.98	37.82
Minimum	0.63	0.91	0.98	0.55	25.99
Mean	1.81	2.70	2.99	2.57	31.50
Standard Deviation (Inches)	0.62	1.05	1.06	1.43	3.40
Coefficient of Variation (Percent)	34	39	35	56	11
SUPERIOR					
Maximum	3.62	4.09	5.60	4.28	35.68
Minimum	0.94	0.71	1.25	0.59	26.30
Mean	2.06	2.18	3.08	2.55	30.90
Standard Deviation (Inches)	0.67	0.84	1.00	1.05	2.50
Coefficient of Variation (Percent)	33	39	32	41	8

Source: Regulation of Great Lakes Water Levels, Appendix A, IGLLB, 1973.

values. The relative amount of winter to summer precipitation increases from northwest to southeast across the Great Lakes basin. Downwind of the lakes where large snowfalls from lake-effect storms occur in winter and summer convective showers are suppressed, the winter precipitation often exceeds that of summer. Snowbelt areas downwind of Lakes Superior and Huron have 20 to 30 percent more winter precipitation than summer precipitation. Similar snowbelt areas southeast of Lakes Erie and Ontario have less predominance of winter precipitation since higher elevations and southern latitudes result in more summer rainfall over the Allegheny and Adirondack Plateaus.

Seasonal snowfall over the Great Lakes varies greatly from year to year. The amount of snow to be expected during a normal winter varies across the basin. Annual snowfalls of less than 20 inches are found to the south of the lower lakes, while annual snowfalls exceeding 140 inches occur in the small areas east (downwind) of Lake Ontario.

Snow cover is a major contributor to spring runoff to the lakes. Again, the winter snow cover in the Ontario basin contributes directly to the same year's spring and summer local inflows, while the contribution from the cover on the other lakes' basins is delayed for months or years.

A determination of the water equivalent of the snow cover is an important factor in forecasting water levels of the lakes. In general, the most significant snow covers accumulate in the northern portions of the basin and where the heaviest snowfalls occur in the lee (downwind) of the lakes.

Intensity of precipitation is an important factor when considering the hydrology of small watersheds. However, the basins of the Great Lakes are so large and the time lags in the lakes so great that the intensity of precipitation is not a major factor in the response of the levels of the lakes. In general, precipitation intensity increases from north to south mainly because of more frequent occurrences of summer convective air mass precipitation in the southern latitudes. The response of lake levels to extremely heavy rainfalls on the land areas is related to the relative wetness of the basin at the time of occurrence.

Over-lake precipitation represents a large and immediate supply of water to the Great Lakes since about one-third of the Great Lakes basin area is lake surface. At the present time, there are no continuous measurements of precipitation over the lakes, although the few measurements which are available indicate that it is slightly more than over land areas. To obtain estimates of over-lake precipitation, measurements of precipitation at land stations on or near the lakeshores are extrapolated over the lake surface.

2.6.6 EVAPORATION

Evaporation is influenced by the climatic characteristics of solar radiation, airmass temperature, humidity, and wind. It occurs from both land and water surfaces of the Great Lakes basin, and a large proportion of the water supplied by precipitation is lost through evaporation from these surfaces.

More than half the annual precipitation which falls on the land basin is lost by evaporation. Using estimates of average basin precipitation and runoff for the years 1935 to 1964, evaporation from the land was calculated by the water balance, assuming that the net storage change and the groundwater flow directly into the lake over this period are negligible. Table 2.7 shows estimates of over-land evaporation for each basin calculated from a water balance.

Table 2.7 - Mean Annual Evaporation (Inches) from Land Portions of the Great Lakes Basin as Determined by the Water Balance Equation

Lake Basin	Precipitation [1]	Runoff [2]	Evaporation [3]	$\frac{\text{Evaporation}}{\text{Precipitation}}$
Superior	29.4	13.9	15.5	53%
Michigan	31.3	11.2	20.1	64%
Huron	31.2	13.5	17.7	57%
Erie	33.7	11.7	22.0	65%
Ontario	34.1	15.5	18.6	55%

[1] 1935-1964 average as calculated from U.S. Lake Survey data.
[2] 1935-1964 average from (7).
[3] Precipitation minus runoff.

Source: Regulation of Great Lakes Water Levels, Appendix A, IGLLB, 1973.

There is no direct means of measuring over-lake evaporation. Several estimates, using energy balance, water balance, and empirical mass transfer relationships, have been obtained for each lake. Although the estimates do not agree because of the variety of methods and periods of record used, they do indicate that evaporation is least in the spring (sometimes condensation occurs) when the lakes are cold relative to the air above them and is greatest in the fall and winter when the lakes are warm relative to the air above them. The water balance evaporation is of a similar magnitude to the precipitation (as determined from land station data) on all the surfaces of the Great Lakes except on Lake Superior where it is considerably less.

2.6.7 WIND

Wind is of interest in any study of lakes since it influences the evaporation from land and water surfaces, short-term levels, and the destructive energy of waves. The speed, direction, and frequency of winds at a given location are a reflection of the passage of weather systems and the local exposure.

In winter, the winds over the Great Lakes are generally westerly with northwest winds prevailing in the north and southwesterly in the south. Summer winds tend to blow from the west and south.

Wind speeds are greatest in the spring and fall. Summer winds are generally more variable in direction and less variable in speed than winter winds. Winds also affect lake levels and flows in the connecting channels and are one of the forces which influence the circulation in the lakes. Table 2.8 gives monthly average perimeter wind speeds for the Great Lakes. Lake Ontario's average perimeter wind speed is 4.8 mph. Overwater speeds differ from overland speeds because of differences in air stability and frictional resistance. No permanent in-lake wind stations exist, however, the maximum over-lake wind speed determined for Lake Ontario by an anemometer-equipped vessel was 57 mph from the north-northwest in November 1964.

Table 2.8 - Average Perimeter Wind Speeds for the Great Lakes (m/s)

Period	Lake: Superior	Michigan	Huron	Erie	Ontario
January	4.6	5.4	4.8	5.5	5.0
February	4.5	5.3	4.4	5.5	5.0
March	4.6	5.5	4.6	5.5	5.0
April	4.8	5.5	4.6	5.4	4.8
May	4.6	5.0	4.2	4.7	4.3
June	4.0	4.3	3.7	4.2	3.9
July	3.8	3.8	3.6	3.8	3.8
August	3.8	3.8	3.5	3.8	3.6
September	4.1	4.3	4.0	4.1	3.8
October	4.4	4.9	4.3	4.4	4.0
November	4.6	5.4	4.8	5.2	4.6
December	4.5	5.3	4.8	5.3	4.8
Annual	4.4	4.9	4.3	4.8	4.4

Values are based on mean data published in 1969 for the following stations:
Superior: Sault Ste. Marie, Marquette, Duluth, and Thunder Bay.
Michigan: Milwaukee, Muskegon, and Green Bay.
Huron: Alpena, Gore Bay, and Wiarton.
Erie: Toledo, Cleveland, Buffalo, and London.
Ontario: Rochester, Syracuse, Trenton, and Toronto.

Source: Great Lakes Basin Framework Study, Appendix 4, GLBC, 1976.

Winds are the driving force for waves. Another factor is the length of "fetch" or open water distance over which the wind blows. The length of fetch depends on lake configuration and wind direction.

2.7 HYDROLOGY

Consideration of hydrologic effects on Lake Ontario must include a review of the hydrology of:

1. the local tributary basins;
2. the lake itself;
3. upstream basins; and
4. upstream lakes.

Items 1 and 3 are considered together herein, as are Items 2 and 4.

2.7.1 HYDROLOGY OF LAND BASINS TRIBUTARY TO THE GREAT LAKES

Precipitation which falls on the land surface moves through several storages during which time some precipitation is lost to evaporation. During freezing weather the precipitation accumulates on the land surface as snow, which is stored until warmer weather causes snowmelt. If there is more water available at the surface from snowmelt or rainfall than can move into the soil, the water will move over the surface as runoff to surface water storages in lakes or swamps or to streams. Some water moves through the soil surface replenishing soil moisture (which plants use as a water supply). When the soil moisture is recharged the remainder of the precipitation moves to groundwater storage. Groundwater storage is the source of springs which, with the outflow from the surface storage in lakes and swamps, provides the dry weather flow for streams. The rainfall during the fall and spring months and snow accumulation during the winter provide the major portion of the water contributed from the land areas to the lakes.

For the land basins of the Great Lakes the relationship of precipitation, evaporation, runoff and storage can be expressed by the hydrologic equation:

$$P_L - E_L - R_L = S_L$$

where P_L is precipitation on land surface

E_L is evaporation from land and plant surfaces

R_L is the tributary stream and direct groundwater runoff to the lake from the land area

S_L is the change in storage on land area as snow on the ground, surface water, soil moisture and groundwater storages.

Precipitation on the land surface and evaporation from land and plant surfaces was discussed in Section 2.6. The relationship of groundwater, physiography and man-made storages to runoff are discussed in the following paragraphs.

Groundwater contributes to the inflow to the lakes as a major contribution to the low summer flow of the tributary streams and as a direct inflow from the shores of the lakes. However, it is generally assumed, based on the limited data available, that the quantities of groundwater flowing directly into the lakes is small and within the range of error of measurement of the water supplies to the lakes. The basis for this assumption is the nature of the surface materials and the deep deposits in the basin. The surface materials are glacial till and are heterogeneous with few extensive aquifers which might yield large quantities of water. Although some areas are underlain by porous limestone and sandstone bedrock which do yield large quantities of water, the orientation of these formations is such that large interbasin water movements are unlikely. However, little is known about basin-wide groundwater movement. As a result no conclusion as to the significance of the contribution of groundwater to the water supplies of the Great Lakes can be made.

The physiography of the basin influences the runoff since increased precipitation and lower evaporation which occur over higher land elevations result in higher runoff. The runoff distribution in time is determined by the nature of the storages on the basin. These storages are dependent on such physiographic characteristics of the land as surface shape, soils and groundwater bearing materials. Surface storage, soil moisture and groundwater determine the base flow characteristics of the streams draining the land areas adjacent to the lakes. These characteristics vary from relatively steep areas with shallow soils with many lakes where high base flows occur to flat areas of heavy clay soil where low base flows occur.

The flows of most of the tributaries to the Great Lakes have been regulated more or less at some time during the period of record. During and following settlement of the Great Lakes basin, particularly in the late 1800's and early 1900's, most streams with adequate fall had grist and saw mills which used the streamflow as a source of energy. Because of their load requirements these mills regulated the streams to some extent. As further settlement took place and the development of large sources of hydroelectric power increased, these small mills fell into disuse. Storage development has continued on tributary streams for hydroelectric power and for flood control. Most hydroelectric development has taken place on the rivers of the Precambrian Shield where concentrations of head were associated with natural lakes which could be developed as reservoirs. Flood control storage has been developed in the upstream areas of streams draining the more densely populated portions of the basin. All of these storages, the operation of which has developed over a period of years, tend to reduce the month-by-month variability of streamflow by storing water in the spring for release later in the year during normal low periods. In the case of hydroelectric power generation, some water is held until the winter months when the high demand for electricity occurs. An evaluation of the effect of such regulation on the natural supplies to the Great Lakes was made as part of the 1973 Great

Lakes Levels Study. It was concluded that the effect of the tributary storages is not significant, considering the size of the lakes and the large basin lag time. Each of the land basins show similar average runoff characteristics as can be seen in Figure 2.12. The hydrographs have been converted to units equivalent to feet of depth on each lake for the flows from its local basin's land runoff.

There is a spring seasonal rise due to snowmelt followed by a gradual recession until the following fall or spring. This demonstrates the importance of the storage as surface water and groundwater to the land runoff pattern. For the upper lakes, Figure 2.12 shows that the month with the highest runoff is May on Lake Superior and April on Lakes Michigan-Huron. On the lower lakes, the peak runoff occurs in March on Lake Erie and in April on Lake Ontario. These peaks are attributable to the accumulation of snow during the winter months and its melting in the spring. Lakes Erie and Ontario demonstrate a tendency to higher runoff in the fall and winter months. This is a result of the fact that a greater proportion of the precipitation during these months occurs as rainfall in the lower lake basins, when land surface evaporation is low. Snowmelt can occur during any winter month on the lower lake basins whereas on the upper lakes the snow cover is more persistent. The variability of the runoff, as demonstrated by the standard deviation, is greatest during snowmelt and during fall and winter months mainly because of the variability of precipitation distribution between rain and snow during these months.

Lake Ontario's inflow hydrograph has a more pronounced peak and a higher peak (in terms of equivalent lake depth) for several reasons:

a. Its small local drainage area in comparison to the other lakes

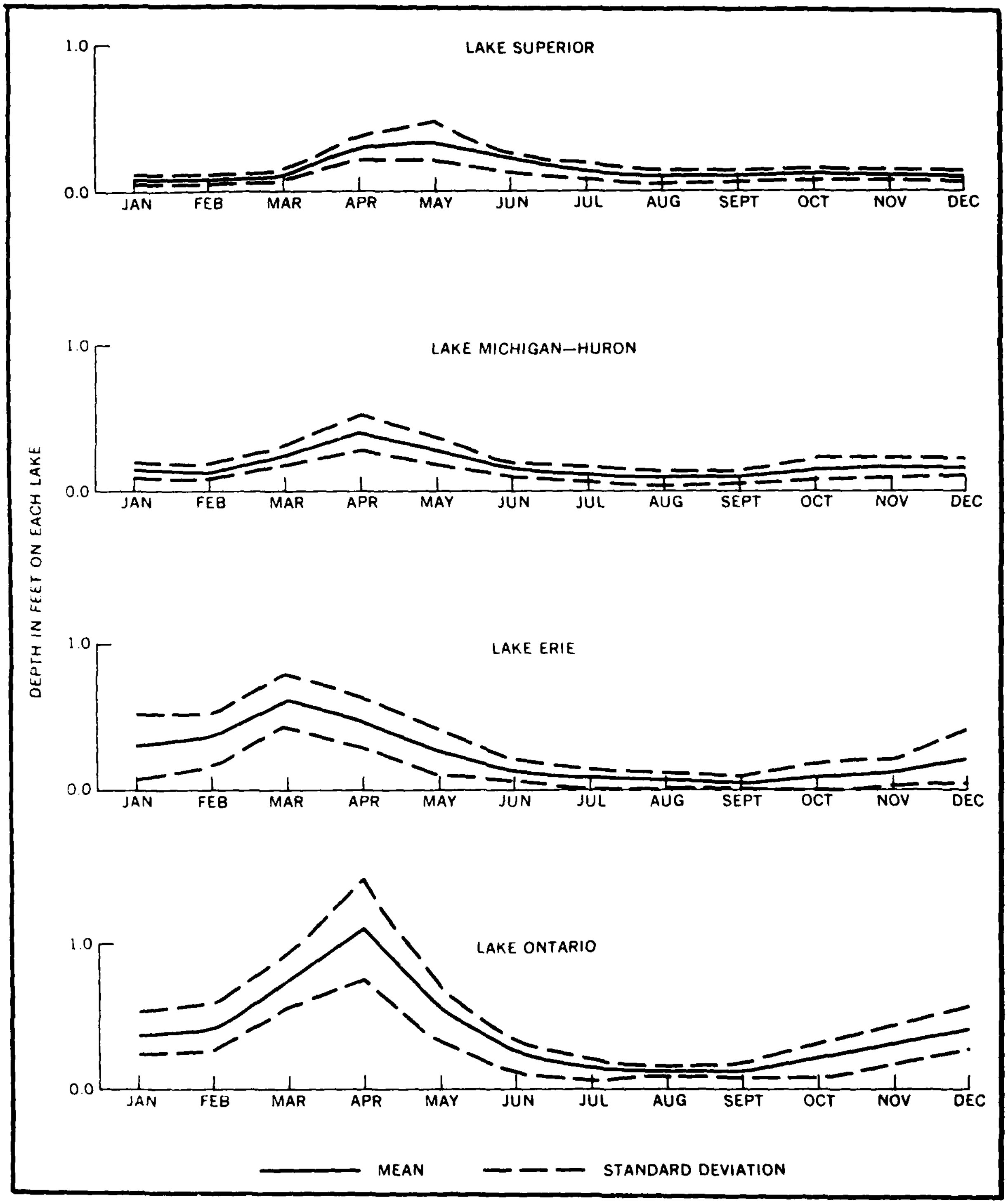
b. Its small surface area which means that for a unit of runoff volume, its level rises proportionately more than the other lakes

c. Its basin has the highest annual precipitation of any of the Great Lakes

d. The lake immediately upstream and which has more effect on Lake Ontario than any of the other lakes is Lake Erie, which for reasons similar to a. through c., also has a relatively high, peaked hydrograph.

Precipitation generally increases from west to east across the Great Lakes Basin and the runoff follows a similar general pattern. However, precipitation increases from north to south whereas runoff decreases in that direction. This anomaly is related to the latitudinal differences. In the north lower evaporation rates result in higher runoff. It should be noted also that areas of high runoff occur in the lee of all the lakes. These areas of high runoff are mainly caused by snowmelt of the heavy snowfalls resulting from the lake effect storms.

From existing knowledge of hydrology, it is logical that man's activities of clearing, draining, irrigating and urbanizing have changed the hydrologic characteristics of the land areas, particularly in the Great Lakes lowlands. Although local hydrologic problems have resulted from these



LAND RUNOFF-SEASONAL DISTRIBUTION
PERIOD OF RECORD 1950-1966

Source: Regulation of Great Lakes Water Levels, Appendix A, IGLLB, 1973

Figure 2.12

activities, most of these changes have taken place gradually over 150 years. Since hydrologic records are available only for the recent 50 to 100 years, the total effect of man's activities on the hydrology of the land basins tributary to the Great Lakes cannot be quantified.

2.7.2 HYDROLOGY OF THE GREAT LAKES

The precipitation on the land areas after losses to evapotranspiration flows into the lake as runoff. Precipitation also falls on the lake surfaces and evaporation is lost from the lakes. It is the purpose of this section to describe the hydrology of the water areas and their relationship to the tributary land areas.

From the law of conservation of matter, the following equation can be written for a lake:

$$\bar{I}\Delta t - \bar{O}\Delta t = \Delta V \qquad 2.1$$

where Δt is some time interval

$\bar{I}$ is the average of the sum of all inflows to the lake over the interval Δt

$\bar{O}$ is the average of the sum of all outflows from the lake over the interval Δt

ΔV is the change in volume or "storage" in the lake for the interval Δt

Δt is usually assumed to be a unit time period, as 1 day, 1 week, etc. For Great Lakes analyses, it is usually set at 1 month. Inflows and outflows are generally given in cubic feet per second (cfs). Note that units in Eq. 2.1 must be consistent. If $\bar{I}$ and $\bar{O}$ are in cfs and Δt is 1 month, then ΔV must be in cfs-months. Generally, Δt is understood to be 1 month and the term is not shown in the equation. Also "storage" in the Great Lakes is generally interpreted to mean the equivalent depth of a volume of water distributed over the entire surface. A change of 80,000 cfs-month in Lake Ontario is equivalent to 1 foot of depth.

Thus for Δt = 1 month, Eq. 2.1 can be rewritten

$$\bar{I}\,(\text{cfs})(\text{month}) - \bar{O}\,(\text{cfs})(\text{month}) = \Delta V\,(\text{cfs})(\text{month}) \text{ or}$$

$$\frac{(\bar{I} - \bar{O})\text{cfs-mo}}{80{,}000 \text{ cfs-mo/ft}} = \frac{\Delta V\text{cfs-mo}}{80{,}000 \text{ cfs-mo/ft}}$$

then $\bar{I} - \bar{O} = \Delta S$

where $\bar{I}$ and $\bar{O}$ are in cfs
t is understood to be 1 month and is not written
ΔS is the change in storage, in feet, or $\Delta V/80{,}000$.

Note that the resulting units are not dimensionally consistent and to use a similar equation on another lake, the correct factor relating storage volume in cfs-mo per foot of level change must be used.

The terms in Eq. 2.1 can be expanded as follows: (Note that Δt is assumed to be 1 month throughout the following discussions).

Input terms (Supply)

$$\overline{I} = \overline{I_u} + \overline{P} + \overline{R} + \overline{G_i} + \overline{D_i} \qquad 2.2$$

where $\overline{I_u}$ is the average inflow from the upstream lake

$\overline{P}$ is the average precipitation on the lake surface

$\overline{R}$ is the average suface water runoff to the lake from its local drainage area

$\overline{G_i}$ is the average surface groundwater flow into the lake

$\overline{D_i}$ is the average artificial diversion into the lake from outside its local tributary area

This expansion shows that the source of all water to the Great Lakes is precipitation whether it is inflow from an upstream lake, runoff from the land, or precipitation on the lake. The water supply from the small diversion into Lake Superior is from the same source, precipitation, as is the source of any groundwater inflow.

$$\overline{O} = Q + E + G_o + D_o$$

where Q is the average lake discharge

E is the average lake surface evaporation

G_o is the average flow from the lake into groundwater

D_o is the average artificial diversion from the lake to other drainage basins.

While water is resident in a lake, some is lost by evaporation. Table 2.9 shows the relative magnitudes of the sources and losses as percent of the average outflow for a 16-year period of October 1950 to September 1966. From this table it can be seen that the precipitation on the large lake areas of the upper lakes represents large volumes of water. However, it is mostly lost by evaporation from the lake surfaces except on Lake Superior. The runoff from the land areas of the upper lakes (Superior and Michigan-Huron) is a significant source of supply whereas, on the lower lakes (Ontario and Erie), the flow from the upstream lake is the principal source of water supply. It should be noted that the tables show that some of the water supply is unaccounted for in Lakes Superior, Michigan-Huron and Erie as a result of lack of precision in the measurement of the various components of

the water supply. The value of the change in storage term (ΔS) over the period (1950-1966) is considered to be zero.

Table 2.9 - Distribution of Average Water Supply to Great Lakes in Percent of Average Outflow (1950-1966)

	Lake Superior	Lakes Michigan-Huron	Lake Erie	Lake Ontario
Inflow from upstream lake (I)	0	46	86	86
Precipitation on lake surface (P)	88	59	12	8
Evaporation from lake surface (E)	-55	-57	-13	-7
Net (P-E)	+33	+ 2	- 1	+1
Runoff from local basin (R)	62	49	12	13
Percent of total outflow accounted for	95	97	97	100
Percent unaccounted for	5	3	3	0
TOTALS	100	100	100	100

Collecting terms in Eq. 2.2 , it becomes

$$I_u + P + R + G_i + D_i - (Q + E + G_o + D_o) = \Delta V$$

$$I_u - Q + P + R - E + (G_i - G_o) + (D_i - D_o) \approx \Delta V \qquad 2.3$$

Because of the lack of information regarding groundwater flows the net Groundwater exchange $G_i - G_o$ is assumed to be zero. The net diversion, $D_i - D_o$ can be represented by D. Then:

$$I_u - Q + P + R + D - E = \Delta V \qquad 2.4$$

This is the water balance equation for any lake. Again, for Lake Ontario

$$\Delta S \text{ (ft)} = \frac{\Delta V \text{ (cfs-mo)}}{80,000}$$

So to determine the change in Lake Ontario storage in feet for 1 month with the average inputs and outputs as defined above, in cfs:

$$\frac{(I_u - Q + P + R + D - E)}{80{,}000}(\text{cfs}) = \Delta S \text{ (ft)}$$

Normally, I_u, Q, and D are measured in cfs, while P, R, and E are measured in inches. Then:

$$\frac{(I_u - Q + D)(\text{cfs})}{80{,}000} + \frac{(P + R - E)(\text{inches})}{12} = \Delta S \text{ (ft)} \qquad 2.5$$

The two characteristics of a lake which respond to changes in supply (see equation 2.5) are the change in storage or change in level represented by ΔS and the lake discharge Q. In any lake or reservoir, if the total outflow supply ($\overline{O}$) is greater than the supply, the level will fall. In the case of an unregulated lake with natural outlet the outlet discharge varies with the level. When the level is high, the depth of water at the outlet is high and the flow of the outlet river is increased. For low levels the converse is true. Under natural outlet conditions as the water supply to the lake changes due to an increase or decrease in its various hydrologic components, principally precipitation and evaporation over land and lake, the lake level and outlet discharge will similarly increase or decrease tending to match the discharge to the supply. Under regulation, the high levels can be lowered a limited amount by increases in discharges up to the maximum capacity of the outlet channels for a given level. Similarly, regulation assumes some form of structure in the outlet channel which will permit reductions in discharges to decrease the rate of level reduction in times of low water supply.

2.7.3 DETERMINATION OF WATER SUPPLIES

Water supply to the Great Lakes is important in forecasting levels and has been analyzed in several previous studies. However, over the period of record of the levels of the lakes, all of the supply components have not been measured. Therefore, it has been necessary to compute water supply data from the water level and outflow data available by manipulation of equation 2.5. These empirical data are the net total supply (NTS) and the net basin supply (NBS).

The net total supply (NTS) is defined as inflow from the upstream lake, plus the inflow from the local tributary land area, plus the precipitation on the lake surface, plus the net diversion, less evaporation from the lake surface. This is shown in the following relationship, the symbols being those used in equation 2.5.

$$NTS = I_u + R + P + D - E \qquad 2.6$$

By substitution in Eq. 2.4,

$$NTS = \Delta V + Q \qquad 2.7$$

Thus, the net total supply is equal to the change in volume for a given time interval plus the average outlet discharge over the same interval. Since both these quantities may be readily measured or estimated, Eq. 2.7 is the common means of estimating NTS.

Equations 2.6 and 2.7 may be applied to each of the Great Lakes without conversion factors as long as the terms are in consistent units, usually cfs-months. For Eq. 2.6, the change in volume, upstream inflow, outlet discharges, and diversion values can be determined directly from lake level and discharge records maintained in Canada and the U.S. However, it is not possible to calculate NTS by relationship for all the lakes, since adequate estimates of precipitation and evaporation for all of the Great Lakes are not readily available.

Net total supplies vary seasonally, being generally higher in the spring and summer months. The range of monthly supplies is shown in Table 2.10.

Table 2.10 - Monthly NTS Values
(CFS-Months)

Lake	Average	Maximum	Minimum	Range
Superior	76,000	359,000	- 95,000*	454,000
Michigan-Huron	183,000	594,000	- 86,000*	680,000
Erie	198,000	343,000	95,000	248,000
Ontario	232,000	382,000	136,000	246,000

* Negative values indicate that evaporation from the lake surface is greater than the total amount of water supplied to the lake.

The monthly net total supplies tabulated were calculated from equation 2.7 with constant diversions of 5,000 cfs in Lake Superior and 3,200 cfs out of Lake Michigan for the study period 1900-1967.

Net basin supply (NBS), which is defined as the net amount of water furnished to a given lake from its local basin, provides an integration of the response of the local tributaries and the lake to precipitation and evaporation.

$$NBS = R + P - E \qquad 2.8$$

From this relationship, it is evident that the net basin supply is dependent only on the hydrologic elements in each local basin and is independent of the diversions and discharges from other basins, since Eq. 2.8 does not include diversions or inflow from upstream lakes.

By substitution in Eq. 2.8,

$$NBS = \Delta V + Q - I_u - D \qquad 2.9$$

As is the case with net total supplies, the individual components of NBS in Eq. 2.8 are not available for all the Great Lakes. The common method for determining NBS is by use of Eq. 2.9, for which the lake volumes, outlet discharges and diversions are available from international records. If NTS has previously been determined net basin supply can be calculated as follows:

$$NBS = NTS - I_u - D \qquad 2.10$$

Eq. 2.10 can be rewritten to solve for V as follows:

$$\Delta V = NBS + I_u + D - Q \quad \text{or}$$

$$\Delta V = NTS - Q$$

Thus, if net total supplies are known or assumed, the effects on lake volume of a given outlet discharge can be calculated. In terms of feet of storage on Lake Ontario:

$$\Delta S(ft) = \frac{NTS\ (cfs\text{-}mo) - Q\ (cfs\text{-}mo)}{80{,}000 \quad cfs\text{-}mo/ft}$$

2.8 LAKE LEVELS

The levels of the Great Lakes are a result of an integration of all of the hydrologic factors which affect the land and the lake surfaces of the basin as well as the hydraulic characteristics of the connecting and outlet channels. Lake level is the characteristic of the lakes which most frequently affects man's use of these waters, since it limits the shoreline use and navigation, and influences the amount of hydroelectric power which can be produced in the connecting channels and outlet river. This section describes the measurement network and the various hydrologic and hydraulic factors which affect the lake levels.

2.8.1 MEASUREMENT OF WATER LEVELS OF THE GREAT LAKES

The water surface elevations of the Great Lakes are recorded by gauges located at strategic points on the lakes and their outlet rivers. The agencies responsible for collection of these data are the Tides and Water Levels Section, Marine Sciences Directorate, Department of Environment for Canada and the Lake Survey Center, National Ocean Survey, National Oceanic and Atmospheric Administration, Department of Commerce and the U.S. Army Corps of Engineers for the United States. Most of the water level gauges used by these agencies are float-activated self-recording instruments. The water levels recorded are referred to a common datum or level -- the International Great Lakes Datum (1955). Elevations referred to this datum are expressed in feet above the mean water level at Father Point, Quebec, Canada. Earliest records date from 1859, but most of these gauges have periods of record of about 30 years. Daily mean and monthly mean values are available for the gauges from the above-named agencies.

2.8.2 LAKE WATER LEVEL VARIATIONS

The levels of the Great Lakes vary both with time and spatially. Short-term water level variations and localized variations are caused by persistent winds and pressure changes, whereas long-term water level variations are caused by changes in lake water volume. Many studies have been made to determine whether the long-term water level variations follow any predictable regular cycle. Other than the seasonal rise and fall each year, no evidence for cycles has been found.

Short period water level changes are usually less than a day in duration. They are local in nature and do not represent changes in the volume of water in a lake.

The shortest period changes of water level are wind generated waves. These have a period of a few seconds. During periods of strong winds surface waves may have heights in deep water areas which are greater than 20 feet from crest to trough. Waves break in shallow water, and their directions are changed. They may break and reform several times before they reach shore. Wind-generated waves are the principal sources of energy for shore erosion. When superimposed on high water levels, wind generated waves can greatly increase erosion and inundation, with a resultant increase in shoreline damages.

Tides caused by the attraction of earth's sun and moon occur on the Great Lakes. The magnitude of these disturbances is in the range of a few inches or less. Compared to other changes in the water levels they are small and can be neglected.

Persistent strong winds tend to build up the level on the downwind shore, reducing the level on the upwind shore. This effect, when combined with the movement of a low pressure system, can cause a significant differential level over the length of a lake.

The changes in levels due to waves, tides, wind and pressure cannot be controlled. When superimposed on high water levels, these effects can cause major erosion and flooding along the shores of the Great Lakes.

Seasonal and longer term variations in the levels of the Great Lakes are usually caused by changes in water supply. The factors affecting the water supplies to the lakes were discussed in Section 2.7. The seasonal variation of the water levels of the Great Lakes is a direct reflection of meteorology. From their lowest levels in the winter the lakes rise as the winter rainfall and spring rainfall and snowmelt run off into them. At this time, lake evaporation rates are low. The evaporation from the land begins to increase and runoff to decrease so that the net basin supply to the lake decreases. Lake surface evaporation increases as the lake warms up during the summer. Increased evaporation each summer combined with decreasing runoff from the land areas result in declining lake levels since the total rate of supply to the lake becomes less than the outlet discharge. Evaporation is greatest in late fall and the differential between precipitation and evaporation increases into the winter months causing mid-winter low lake levels.

Any lengthy period of persistent high rainfall and low evaporation over the several basins of the lakes results in higher lake levels. Conversely, a persistent dry period with high evaporation and low rainfall results in low lake levels. The lengths of such periods and the intervals between them are variable. If these meteorologic trends are on the order of several months to years, the annual average levels are accordingly higher or lower, and the seasonal variations are then superimposed on the longer term levels.

Long-term changes in lake levels are also related to the geomorphology of the Great Lakes basin. Uplift of several hundred feet has occurred in some places in the area during the thousands of years since glacial times. The effects of this phenomenon on the water level regime of each of the Great Lakes has been determined by the Canada-United States Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data and documented in reports of that Committee. The effect of differential crustal movement is not uniform; generally, the rates around Lakes Superior and Ontario are greater than those around Lakes Michigan-Huron and Erie. Since vertical movement studies are usually carried out by water level records comparison, factors which may affect the accuracy of computed movement rates include: changes in gauging sites; unstable vertical control survey points; limitation of gauging and vertical control measuring instruments and procedures; and local subsidence.

The effects on water levels of differential crustal movement may be better understood if the lakes are visualized as basins which are being tilted by a gradual raising of their northeastern rims. As time goes on, the water levels along shores that are situated south and west of lake outlet are rising higher on these shores for a given water level elevation. Similarly, water levels along the shores at localities north and east of the outlet are receding with respect to the land.

2.8.3 RELATIONSHIP BETWEEN OUTLET CHANNEL DISCHARGE AND LAKE LEVELS

The higher the lake level at the entrance to one of the outlet channels, the greater the dicharge of the channel. For the range of levels usually encountered, a linear relationship approximates the lake level vs. channel discharge function under natural conditions.

2.8.4 NATURAL CONTROLS

At the present time two of the four Great Lakes have uncontrolled outlet channels. These are Lakes Michigan-Huron and Erie. The Lake Michigan-Huron discharge is controlled by the dimensions of the St. Clair and Detroit Rivers, and the downstream levels on Lakes St. Clair and Erie. There are no large diversions bypassing this system of channels. On the average, there is about 8 feet of fall between Lakes Michigan-Huron and Lake Erie. This fall occurs over a distance of about 80 miles.

Except for the water diverted from Lake Erie into the Welland Canal and from the Niagara River into the New York State Barge Canal, the entire outflow from Lake Erie passes through the Niagara River to upstream Niagara Falls where power diversions are made around the Falls.

As ice cover forms on a river in areas with sufficiently low velocities, it consolidates, converting the open channel into a closed channel similar to a pipe with resultant increases in head loss. However, if the velocities are greater than about 2.5 feet per second as they are in many parts of the connecting channels of the Great Lakes, generally a stable ice cover cannot be maintained. As a result, ice floes are swept through the high velocity areas and tend to turn up on-end or to submerge under the head of stable downstream ice cover. When this happens an ice jam or hanging dam forms. This results in a constriction in the channel, and the discharge capacity may become seriously reduced. These effects can occur in the outlets of both regulated and unregulated lakes. A technique used to minimize the chance of ice jamming and the formation of a hanging dam is to reduce the flow at the onset of ice formation so that the velocities are lowered in the critical sections of the river to allow a consolidated smooth ice cover to form. However, a control or regulating structure must be available in the river in order to utilize this technique.

Variations in nutrient content of surface waters can result in a variation in intensity of vegetative growth in the waters of the lakes and outlet channels. In shallow areas less than 10 feet in depth, heavy bottom growth can significantly increase hydraulic roughness, which in turn reduces the channel discharge capacity. This condition exists in the Niagara River, which has large areas of relatively shallow water. This effect may amount to as much as a 10,000 cfs reduction during the period June to September. In the other connecting channels, small weed retardations may occur, but insufficient data are available to confirm these effects.

2.8.5 CHANNEL MODIFICATIONS AND REGULATION

Man has made channel improvements for navigation, and built navigation locks, hydroelectric power generating stations, and control dams on the connecting channels of the Great Lakes. Bridges and shore structures have also been built. These alterations have changed the natural level-outflow relationships of the lakes.

In the mid-30's, dredging was undertaken in the St. Clair and Detroit Rivers for a 25-foot navigation project. In 1962, a 27-foot project was completed. The material dredged in deepening the channels for the navigation projects was, in large part, deposited in the river in areas where it does not impede navigation. However, it is estimated that the uncompensated effect of the 25- and 27-foot projects has been to lower the levels of Lakes Michigan-Huron approximately 7 inches.

Although there have been small changes in the Niagara River below Buffalo to accommodate the Black Rock Canal and navigation channels in the Niagara River, these changes have not measurably affected the discharge of the Niagara River, nor the levels of Lake Erie.

Two of the outlet channels of the Great Lakes contain regulation works for controlling the outflow. The St. Marys River contains compensating works and hydroelectric generating stations at Sault Ste. Marie for regulating the outflow from Lake Superior. The St. Lawrence River contains a hydroelectric

generating station at Cornwall, Ontario, and two dams, Long Sault near Massena, NY, and Iroquois Dam near Iroquois, Ontario, for regulating the outflow from Lake Ontario. Regulation of Lake Superior and Lake Ontario are accomplished jointly by the United States and Canada through international boards established by the International Joint Commission.

Since completion of the control works in the St. Marys River in August 1921, outflows from Lake Superior have been completely regulated in accordance with the Orders of Approval of the International Joint Commission issued May 26 and 27, 1914. The regulation plans developed by the Lake Superior Board of Control have been modified several times to obtain improved results. The first plan, the Sabin Rule, was replaced in 1941 by a plan designated as Rule P-5. The Rule of 1949 was subsequently developed in recognition of the increased supplies to Lake Superior from the Long Lake-Ogoki Diversion. In December 1955, the Rule of 1949 was modified to obtain improved results. This modified rule remained in effect until October 1979 when it was replaced with Plan 1977. The implementation of Plan 1977 was accompanied by an amendment to the 1914 Orders of Approval calling for systemic regulation as one of the Commission's regulation objectives. Plan 1977 is systemic in nature because supply conditions on Lakes Michigan-Huron, as well as Lake Superior, are considered in determining regulated releases from Lake Superior.

Regulation of the outflow from Lake Ontario was made possible by the construction of the St. Lawrence Seaway and Power Development in the 1950's. The regulation, in accordance with the International Joint Commission's Orders of Approval of October 29, 1952 and Supplementary Order of July 2, 1956, began in April 1960 under the supervision of the Commission's International St. Lawrence River Board of Control (ISLRBC). The initial regulation plan, 1958-A, was replaced in January 1962 by Plan 1958-C. Plan 1958-C was developed to reduce the frequency of occurrence of low levels at Montreal Harbor with respect to those being achieved under Plan 1958-A. Additional improvements, including a further reduction in the frequency of low levels at Montreal were achieved with the implementation of the current regulation plan, Plan 1958-D, in October 1963.

By altering the natural magnitude and sequence of outflows from Lakes Superior and Ontario, regulation has modified the levels of these lakes and water levels in the areas downstream, from those that would have existed under natural conditions.

2.8.6 DIVERSIONS

There are four major diversions in the Great Lakes system. Two increase the supply to the Great Lakes, one decreases the supply, and the other bypasses the natural outlet river.

Canadian waters are diverted from the Albany River basin, part of the James Bay drainage, via the Long Lake and Ogoki Diversion Projects into the Lake Superior basin. These projects commenced operation in 1939 and 1943, respectively, and have increased the water supply of the Great Lakes system and thus its water levels. During the period 1943 through 1970 the sum of these diversions has averaged about 5,000 cfs.

Since 1848, water has been diverted at Chicago from Lake Michigan into the Mississippi River basin, averaging about 50 cfs until 1900 and thereafter increasing progressively until a maximum annual average of about 10,000 cfs was reached in 1928. The diversion then decreased progressively to an average of 3,100 cfs. From 1953 to 1970, with few exceptions, the mean annual diversion has been about 3,300 cfs. Effective 1 March 1970, by a decree of the United States Supreme Court dated 12 June 1967, the maximum annual allowable diversion from Lake Michigan at Chicago is 3,200 cfs, including domestic pumpage. The accounting period is a 12-month term ending on the last day of February. A period of 5 years consisting of the current annual accounting period and the four previous accounting periods is permitted, when necessary, for computing the average diversion. The average diversion in any one annual accounting period shall not exceed 110 percent of the maximum diversion.

In addition to lowering Lake Michigan-Huron, the Chicago Diversion reduces the supply to the Lower Great Lakes and thus lowers the water levels in the downstream system except for those in Lake Ontario which is regulated.

A fourth major diversion, which occurs within the system, is made from Lake Erie to Lake Ontario through the Welland Canal. This diversion for navigation and power purposes has averaged about 7,000 cfs from 1950 through the mid-60's and gradually increased to about 9,000 cfs by the late 70's. This has lowered Lake Erie levels and slightly lowered Lakes Michigan-Huron levels, since the latter have a minor dependence on the former.

The effect of the four major diversions on each of the lakes and Montreal Harbor is shown in Table 2.11.

Table 2.11 - Major Diversions (as of 1970) and Their Ultimate Effects on the Levels of the Great Lakes and Montreal Harbor (In Feet)

Diversion	Average Amount (cfs)	Lake Superior*	Lakes Michigan-Huron	Lake Erie	Lake Ontario*	Montreal Harbor
Long Lake and Ogoki	5,000	0	+0.37	+0.23	0	+0.22
Chicago	3,200	-	-0.23	-0.14	0	-0.15
Welland Canal	7,000	-	-0.10	-0.32	0	0
Net Effect			+0.04	-0.23		+0.07

*Regulation plans for these lakes have been designed to accommodate the diversions.

Within the Great Lakes system, minor lowerings result from withdrawals for municipal water supply when the effluent is returned to the next lower lake. For example, minor lowerings of Lakes Michigan-Huron result from withdrawals for domestic water supply for the Detroit, Michigan and London, Ontario areas, since these withdrawals bypass the St. Clair and Detroit Rivers, but are discharged into Lake Erie. A minor diversion averaging about 700 cfs annually from the Niagara River at Tonawanda, NY, primarily for navigation purposes on the New York State Barge Canal, has caused an insignificant lowering of Lake Erie.

2.8.7 CONSUMPTIVE USE OF GREAT LAKES WATER

The term "consumptive use" refers to that portion of the water withdrawn or withheld from the Great Lakes and not returned. For the purposes of this study the diversion of water from Lake Michigan at Chicago is excepted from this definition. It includes water utilized by crops, incorporated into manufactured products, used in industrial processes, consumed by man or livestock, or otherwise expended. The water so consumed in any of the separate lake basins constitutes a reduction in the net supply to that lake and therefore subsequently to each of the downstream lakes. Consumptive use of water has been estimated under seven withdrawal categories; thermal-electric power generation, irrigation, municipal, rural domestic, manufacturing, mining, and rural stock.

It should be noted that the gradually increasing consumptive use of water contributes to a gradual decrease in the net water supplies to the Great Lakes basin which, in turn, lowers the levels of the lakes and reduces their outflows, a consequence which is cumulatively greater downward through the chain of Great Lakes. The most likely projection (MLP) of total consumptive uses in 2035 shown on Table 2.12 represents an increase of 20,500 cfs from 1975, which is equivalent in magnitude to 8.6 percent of the mean outflow of the St. Lawrence River.

Table 2.12 - Most Likely Projection of Total Consumptive Uses

Lake	1975	2000	2035
Superior	240	380	740
Michigan-Huron	1,960	4,140	10,550
Erie	2,210	4,000	9,490
Ontario	530	1,370	4,570
Total	4,940	9,890	25,400

These projections were extracted from a study recently completed by the International Great Lakes Diversions and Consumptive Uses Study Board.

2.8.8 LONG-TERM TRENDS

Ice control through the use of ice booms and ice-breaking ships changes the natural river regime. Floating ice booms are used to stabilize the ice cover and winter hydraulic regime and prevent its deterioration through runs of broken ice which can create ice jams and large head losses with reduced channel capacity. Ice breaking ships may break up a stable ice cover which may result in near open-water conditions with little reduction in channel capacity due to ice. These two factors can be artificial influences on the hydraulics of the connecting channels of the Great Lakes. If ice control continues during successive winters reducing the natual ice retardation, it will have the long-term trend of increasing the winter outflows in the connecting channels. Other long-term trends may develop due to increased flow retardation by weeds and consumptive use. However, insufficient data are available to determine whether the above activities have caused any measurable change in the levels and flows of the Great Lakes.

2.8.9 LAKE ONTARIO REGULATION

a. Historical Overview

The natural regime of the Lake Ontario outlet, the St. Lawrence River, has undergone changes since 1825. These changes, which have included channel modifications and structures, were constructed for navigation and power generation. It was not until 1958, with the construction of the St. Lawrence Seaway and Power Project, that man was able to regulate the outflow of Lake Ontario.

In 1952, the Governments of Canada and the United States applied to the International Joint Commission for approval to construct certain works for the development of power in the International Rapids Section of the St. Lawrence River. These works include the Moses-Saunders Dam and Powerhouse, the Long Sault Dam, the Iroquois Dam, and extensive channel enlargements. These works were designed to cope with the worst known water supply conditions during the 95-year period preceding 1955. After holding a number of public hearings the Commission granted its approval, subject to a number of conditions, with the issuance of its Orders of Approval, dated 29 October 1952, and amended by a Supplementary Order dated 2 July 1956. The Orders of Approval recognized the priorities of use of the waters of the St. Lawrence River as established by the Boundary Waters Treaty of 1909. This Treaty specified that the highest precedence be given to the use of water for domestic and sanitary purposes, followed by uses for navigation, power, and irrigation in that order.

The Orders of Approval specified that the project works be so designed, constructed, maintained, and operated as to safeguard so far as possible the rights of all interests affected by the levels of Lake Ontario and the St. Lawrence River upstream from the project; that the project works be operated in such a manner as to provide no greater damage to navigation and riparian interests downstream than would have occurred under preproject conditions; that the discharge of water from Lake Ontario be regulated to maintain the lake level within a range of stage of mean monthly elevation

242.77 feet (navigation season) to elevation 246.77 feet (IGLD), as nearly as may be, and; that the discharge of water from Lake Ontario be regulated in accordance with certain criteria set forth by the Commission. The range of stage and the criteria for regulation, subsequently set out in the Commission's Supplementary Order were approved, interalia, by the two Governments in 1955. The criteria are as follows:

"a. The regulated outflow from Lake Ontario from 1 April to 15 December shall be such as not to reduce the minimum level of Montreal Harbour below that which would have occurred in the past with the supplies to Lake Ontario since 1860 adjusted to a condition assuming a continuous diversion out of the Great Lakes Basin of 3,100 cubic feet per second at Chicago and a continuous diversion into the Great Lakes Basin of 5,000 cubic feet per second from the Albany River Basin (hereinafter called the "supplies of the past as adjusted").

"b. The regulated winter outflows from Lake Ontario from 15 December to 31 March shall be as large as feasible and shall be maintained so that the difficulties of winter power operation are minimized.

"c. The regulated outflow from Lake Ontario during the annual spring breakup in Montreal Harbour and in the river downstream shall not be greater than would have occurred assuming supplies of the past as adjusted.

"d. The regulated outflow from Lake Ontario during the annual flood discharge from the Ottawa River shall not be greater than would have occurred assuming supplies of the past as adjusted.

"e. Consistent with other requirements, the minimum regulated monthly outflow from Lake Ontario shall be such as to secure the maximum dependable flow for power.

"f. Consistent with other requirements, the maximum regulated outflow from Lake Ontario shall be maintained as low as possible to reduce channel excavations to a minimum.

"g. Consistent with other requirements, the levels of Lake Ontario shall be regulated for the benefit of property owners on the shores of Lake Ontario in the United States and Canada so as to reduce the extremes of stage which have been experienced.

"h. The regulated monthly mean level of Lake Ontario shall not exceed elevation 246.77 with the supplies of the past as adjusted.

"i. Under regulation, the frequency of occurrences of monthly mean elevations of approximately 245.77 and higher on Lake Ontario shall be less than would have occurred in the past with the

supplies of the past as adjusted and with present channel conditions in the Galops Rapids Section of the St. Lawrence River. ("present channel conditions" refers to conditions as of March 1955).

"j. The regulated level of Lake Ontario on 1 April shall not be lower than elevation 242.77. The regulated monthly mean level of the lake from 1 April to 30 November shall be maintained at or above elevation 242.77.

"k. In the event of supplies in excess of the supplies of the past as adjusted, the works in the International Rapids Section shall be operated to provide all possible relief to the riparian owners upstream and downstream. In the event of supplies less than the supplies of the past as adjusted, the works in the International Rapids Section shall be operated to provide all possible relief to navigation and power interests."

Realizing that in the future supplies could be more extreme than those occurring over the past 95 years (at the time of adopting Criteria "a" thorugh "j"), the Commission added Criterion "k" to its 1956 Supplemental Orders of Approval.

The Commission also established the International St. Lawrence River Board of Control in 1953 to monitor the operation of the St. Lawrence Project to insure compliance with the requirements of the Orders of Approval. In doing so, the Board is responsible for advising the Power Entities (Ontario-Hydro and the Power Authority of the State of New York), of the weekly outflow from Lake Ontario. The Order of Approval states that the Board should develop and make provision for adjustments and progressive improvements to a plan of regulation.

The development of a plan of regulation for Lake Ontario came into focus in 1952 when the Governments of Canada and the United States requested the International Joint Commission to investigate whether Lake Ontario could be regulated to reduce the extremes of stage, having regard to the proposed St. Lawrence Seaway and Power Project. Following the submittal of an interim report, the Commission tentatively concluded that Lake Ontario could be regulated within a range of 242.8 feet (navigation season) and 246.8 feet (IGLD). A plan of regulation, designated Plan 12-A-9, was developed within the above range of stage to meet the proposed criteria and other requirements of the Orders of Approval. In its Supplementary Orders of 1956, the Commission incorporated the above range of water levels and employed Plan of Regulation No. 12-A-9 as the basis for calculating critical profiles and designing channel excavations in accordance with the requirements of its Order of 1952. The report forwarding Plan 12-A-9 concluded that further studies were necessary to incorporate additional adjustments. The International St. Lawrence River Board of Control conducted such studies and in its report, dated 14 May 1958, recommended the adoption of Plan 1958-A "as the initial operating plan for the regulation of the levels and outflows of Lake Ontario, having in mind that certain revisions may be necessary in the light of further studies and operating experience." Between 1958 and 1960 the lake

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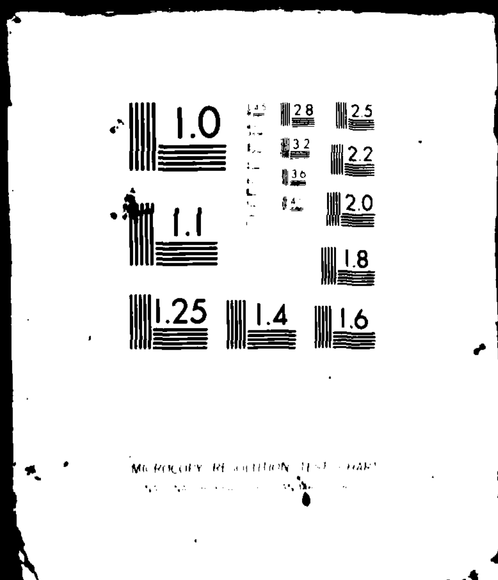


outflows were regulated to their preproject values, i.e., the outflows that would have occurred under St. Lawrence River channel conditions existing in March 1955. Plan 1958-A was implemented on 20 April 1960.

Events during 1960 resulted in a re-examination of the manner in which Plan 1958-A met the requirements of downstream navigation interests, particularly Montreal Harbour. Further studies were conducted utilizing operating experience. As a result of these studies, the Board, in its report on Regulation of Lake Ontario - Plan 1958-C, dated 5 October 1961, recommended the "adoption of Plan 1958-C to replace 1958-A for regulation of the levels and outflows of Lake Ontario, having in mind that certain revisions may be necessary in the light of further studies and operating experience." Plan 1958-C was implemented on 3 January 1962.

By letters dated 21 January 1963, the Board was again requested to proceed with further studies "to provide, among other possible benefits, for improvement of the levels of Montreal Harbour . . ." In its report dated July 1963, the Board recommended "adoption of Plan 1958-D to replace Plan 1958-C for regulation of the levels and outflows of Lake Ontario, having in mind that certain revisions may be necessary in the light of further studies and operating experience." Plan 1958-D was implemented on 4 October 1963.

Early in the regulation experience on Lake Ontario, it was realized that rigid rule regulation plans cannot take into account special needs of the various interests which might occur on a short-term basis. Further, the week-by-week regulation deliberations can take into account a whole spectrum of data which can influence regulations decisions, but which is not available for inclusion in a theoretical test of the plan over the period of record. It was for these reasons that, in 1961, the Board requested and received authority from the Commission to depart temporarily from the approved plan of regulation when a deviation in outflow from Lake Ontario, of limited magnitude and duration, would provide beneficial effects or relief from adverse effects to an interest concerned with the regulation of Lake Ontario, without appreciable adverse effects to any of the other interests concerned, either during the period of deviation or subsequent thereto. Flow deviations which meet the above criteria are considered to be made under the discretionary authority granted to the Board. By previous directives the Commisison had granted to the Board the authority to make flow deviations from the plan during emergency situations, during winter operations (the permissible flow is often dictated by the prevailing ice conditions), and during those periods when the Commission has determined that regulation should be conducted in accordance with Criterion (k). For simplicity in this report, all deviations from procedural plan flow, regardless of purpose, are referenced hereafter as discretionary actions by the Board.

b. <u>Existing Operational Regulation Plan, Plan 1958-D</u>

Since its adoption in 1963, the current operational plan for regulation of Lake Ontario outflow has been Plan 1958-D, supplemented with the Board's discretionary authority. This refined plan was developed to provide greater benefits to all interests while satisfying the criteria and other requirements that have been established. Similar to the previous plans, Plan 1958-D

establishes rules which indicate the outflow to be released for various conditions of lake levels and supplies.

Plan 1958-D is tailored to the supplies of the past, as adjusted, using the preproject stage-discharge curve as a basis for the rule curves, and by adjustments to the rule curve and flow specified, depending on the Lake Ontario level and the water supply. The outflows prescribed by the rule curves are then subject to certain maximum and minimum flow limitations to insure that the criteria and other requirements of the Orders of Approval are satisfied.

The plan utilizes three steps to determine the regulated discharge. The first step derives the basic regulated outflow from a family of rule curves, which are a function of Lake Ontario water level and indices of supply. The second step adjusts the basic regulated outflow by applying a seasonal adjustment. The third and final step compares the resultant seasonal adjusted outflow with the maximum and minimum outflow limitations, which have been selected to meet various requirements of regulation, e.g., criteria specified in the Orders of Approval. These outflow limitations vary throughout the year. If the seasonal adjusted outfow is between the minimum and maximum limitations for the period, it is adopted as the regulated outflow unless the Board directs a flow deviation as noted above. If it is higher than the maximum limitation or lower than the minimum limitation, the applicable outflow limitation is adopted as the regulated flow. A more detailed discussion of Plan 1958-D is provided in Regulation of Lake Ontario - Plan 1958-D, Report to the International St. Lawrence River Board of Control, dated July 1963.

c. Constraints Associated with Regulation

There are certain constraints placed upon regulation which limit the ability to provide better regulation for Lake Ontario water levels. One is the physical capacity of the St. Lawrence River. The physcial configuration of the channel limits the amount of water which can be discharged while at the same time meeting the IJC's established criteria and other requirements for the regulation of Lake Ontario. Construction of the St. Lawrence Seaway and Power Projects provided for the enlargement of some of the river channel to increase the discharge capacity of the river and thus provide for reduced velocities for navigation, and for proper ice cover formation in the winter to maintain the hydraulic capacity. However, in spite of the ability to discharge greater flows at a given lake level than occurred under preproject conditions, the physical dimensions of the river in relationship to channel velocity, ice formation, and downstream flooding remain a constriant on controlling lake levels to elevation 246.77, as nearly as may be, when supplies are of the magnitude experienced in the 1970's.

Another constraint pertains to Criterion (d) of the Orders which states that, during the annual flood discharge from the Ottawa River the regulated outflow from Lake Ontario shall not be greater than would have occurred under preproject conditions. During some of the most critical periods of the 1970's this was one of the criteria which had to be violated during the Board's discretionary operations in accordance with Criterion (k) in order to meet the philosophy of that Criterion d.

The inability to accurately forecast supplies also constrains the regulation of lake levels at times. Reliable forecasts are necessary to optimize the use of storage on Lake Ontario and to utilize the river capacity through its full range in anticipation of high or low supplies. Current regulation policy is based upon a probability forecast, giving consideration to the conditions of the upstream lakes. This forecast is used by the Board as one of its guides to determine whether Criterion (k) should be invoked. These forecasts represent the state-of-the-art for probabilistic techniques. Major improvements in reliability cannot be achieved until detailed, reliable long-term weather forecasts become available.

It should be emphasized that accurate long-range weather forecasts can provide significant benefits only when extreme supplies are of limited duration. In those cases where extreme supplies persist for many months, the advantages of anticipatory action are dissipated over time as the physical limitations of the channel and associated factors become the overriding constraint on outflow from Lake Ontario.

To illustrate this point, the International St. Lawrence River Board of Control's Working Committee made computations using historical data beginning 1 August 1970 through June 1973. It was assumed that the release each week was equal to the maximum outflow which could be discharged with only the navigation depth requirement to be satisfied. The constraints pertaining to maximum channel velocity and criterion (d) (maximum outflow during Ottawa River floods) were ignored. The maximum computed level, occurring in May 1973, was only 0.5 foot lower than the actual level achieved by the Board exercising its discretionary authority. This is not a significant lowering when one considers that during this exercise maximum discharges were released each week beginning more than 2 years before the advent of the extreme supplies in late 1972. The maximum lake level limitation was still exceeded by more than 0.7 foot in this exercise. It can be concluded that, even with perfect long-range forecasting ability, the existing river capacity is such that it will not always be possible to maintain Lake Ontario levels within the maximum limit prescribed by the Orders of Approval, if excessively high supplies persist for extended periods.

The assumptions in the above study, i.e., perfect forecasting of supplies and utilizing the full capacity of the river without regard for downstream flooding, are theoretical conditions which, in fact, are not attainable. In order to provide protection to the various interests, the criteria and other requirements specified by the Orders of Approval impose limitations on the amount which can be discharged. Any change to these limitations would result in a redistribution of benefits and/or damages among the interests. The regulation plan, control structures, and channel enlargements were designed so that the limitations would not be exceeded under supply conditions experienced from 1860 through 1954, and the acceptance of the distribution of benefits was based on this long period of supplies. It has been during relatively recent abnormal supply conditions, more extreme than those on which the project was designed, that the limitations have been violated despite the use of discretionary authority by the Board. The Commission has reserved to itself the responsibility to indicate the interrelationship of the criteria and other requirements of the Order,

i.e., the Commission determines the priority of the criteria and requirements when violation is necessary.

2.9 AIR QUALITY

Air pollution affects suburban and rural areas as well as industrialized areas. It can have a harmful effect on human health, aesthetic and cultural resources, property, wildlife, water quality, and vegetation. Recognizing this threat to social well-being and to the environment, the Federal Government established its leadership in developing programs to counter air pollution by passing the Clean Air Act of 1975 (40 CFR 55: 1975). This program is administered by the U. S. Environmental Protection Agency (USEPA). All of the Great Lakes States have air quality standards set by USEPA under the Act, as well as plans acceptable to meet the Federal standards.

New York State's existing air quality classification system is divided into four levels ranging from "Level I" - areas where the atmosphere is relatively free of pollutants - to "Level IV" - areas where the air is heavily ladened with contaminants. Table 2.13 briefly outlines criteria associated with each classification level as described in Part 256 of Title 6 - Compilation of Codes, Rules and Regulations of the State of New York - subchapter A of Chapter III (Environmental Conservation Law).

Table 2.13 - New York State Air Quality Classifications

Level I	Predominant use is for timber, agricultural crops, dairy farming, or recreation. Habitat and industry sparse.
Level II	Predominantly single and two family residences, small farms, limited commercial services and industrial development.
Level III	Densely populated, primarily commercial office buildings, department stores, and light industries in small and medium metropolitan complexes, or suburban areas of limited commercial and industrial development near large metropolitan complexes.
Level IV	Densely populated, primarily commercial office buildings, department stores, and industries in large metropolitan complexes, or areas of heavy industry.

In general, air quality along the Lake Ontario-St. Lawrence shoreline is classified as being Level I - except for the several following specific areas located in Niagara, Monroe, Oswego, and St. Lawrence Counties (see Figure 2.13):

(a) The area in the northwest corner of Niagara County, where the Niagara River enters Lake Ontario, is classified as Level II.

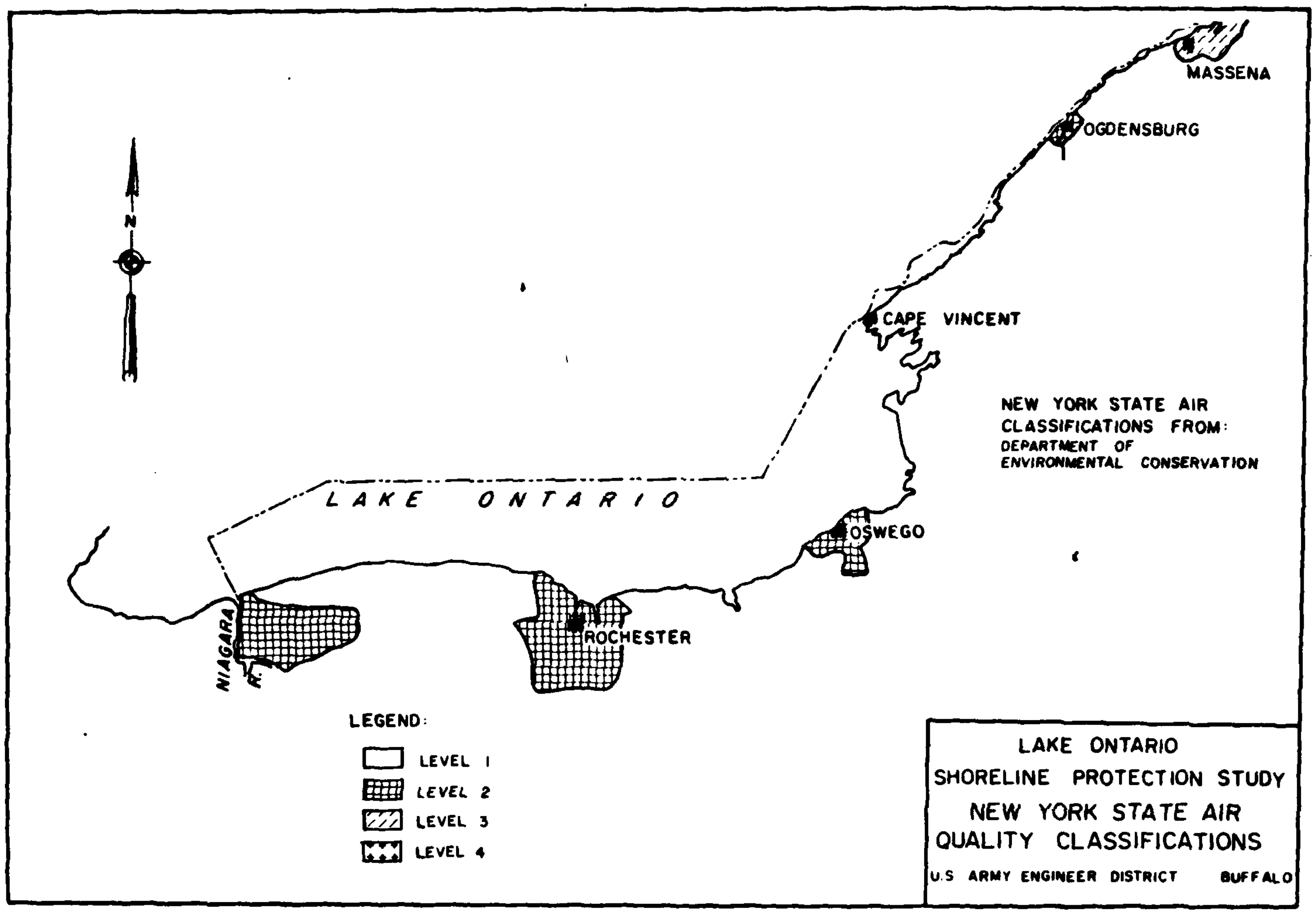

MASSENA
OGDENSBURG
CAPE VINCENT
NEW YORK STATE AIR
CLASSIFICATIONS FROM:
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
LAKE ONTARIO
OSWEGO
ROCHESTER
NIAGARA R.
N
LEGEND:
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
LAKE ONTARIO
SHORELINE PROTECTION STUDY
NEW YORK STATE AIR
QUALITY CLASSIFICATIONS
U.S ARMY ENGINEER DISTRICT BUFFALO

Figure 2.13

(b) Monroe County has a large area identified as Level II air quality bordering the Lake that extends eastward from about Manitou Road in the town of Hilton, to Salt Road outside the town of Webster. This area extends southward between these two points to almost the boundaries of Monroe, Livingston, and Ontario County.

(c) Oswego County has a Level II area adjacent to the shoreline in the vicinity of the city of Oswego. The western boundary of this area extends to the shoreline from approximately the intersection of the Oswego-Hannibal townlines with Route 104. Moving eastward from this line, the Level II area along the lake extends to about Klocks Road in the township of Scriba.

(d) St. Lawrence County has two areas not designated as Level I. The first area located within the corporate city limits of Ogdensburg, is classified as Level II. The second area, located from about the eastern half of the village of Massena, eastward to the Massena-Franklin Counties border, is designated as Level III.

Coastal zone air quality is monitored by State air sampling stations as shown on Figure 2.13a. The sampling results for 1978 showed that sulphur dioxides, carbon monoxides, nitrogen dioxides, photochemical oxidants, lead and particulates concentrations were generally well below the ambient air standards allowable by New York State.

Even though most of the air quality along the Lake Ontario-St. Lawrence River shoreline is categorized as being in Level I, it should be noted that New York State's recent Coastal Zone Management Program report (1979) points out that "major air quality management concerns in the coastal managment area are grouped into four general categories: the attainment and maintenance of national air quality standards as proposed in the State Implementation Plan; protection of clean air areas from significant deterioration; air pollution control problems in rural areas and, control of toxic discharges into the air." The report further emphasizes that it is New York State policy that "land use or development in the coastal area shall not cause national or State air quality standards to be violated."

2.10 WATER QUALITY

2.10.1 OPEN-LAKE

The open-lake is considered Class A by the NYSDEC. The best usage of these waters is as a source of water for drinking, food processing, and other uses such as contact recreation and fishing (NYSDEC, Title 6, Chapter 10).

"Analysis of the data collected during nine 1978 cruises in the offshore waters (<2 km) of Lake Ontario indicate a continuation of the total phosphorus decrease reported in 1977. This suggests that the lake is gradually approaching its recommended state (10 ug/L phosphorus, spring concentration). Trend analysis by linear regression and rank correlation methods also indicates that the volume weighted mean lakewide total phosphorus concentration has decreased steadily over the last few years.

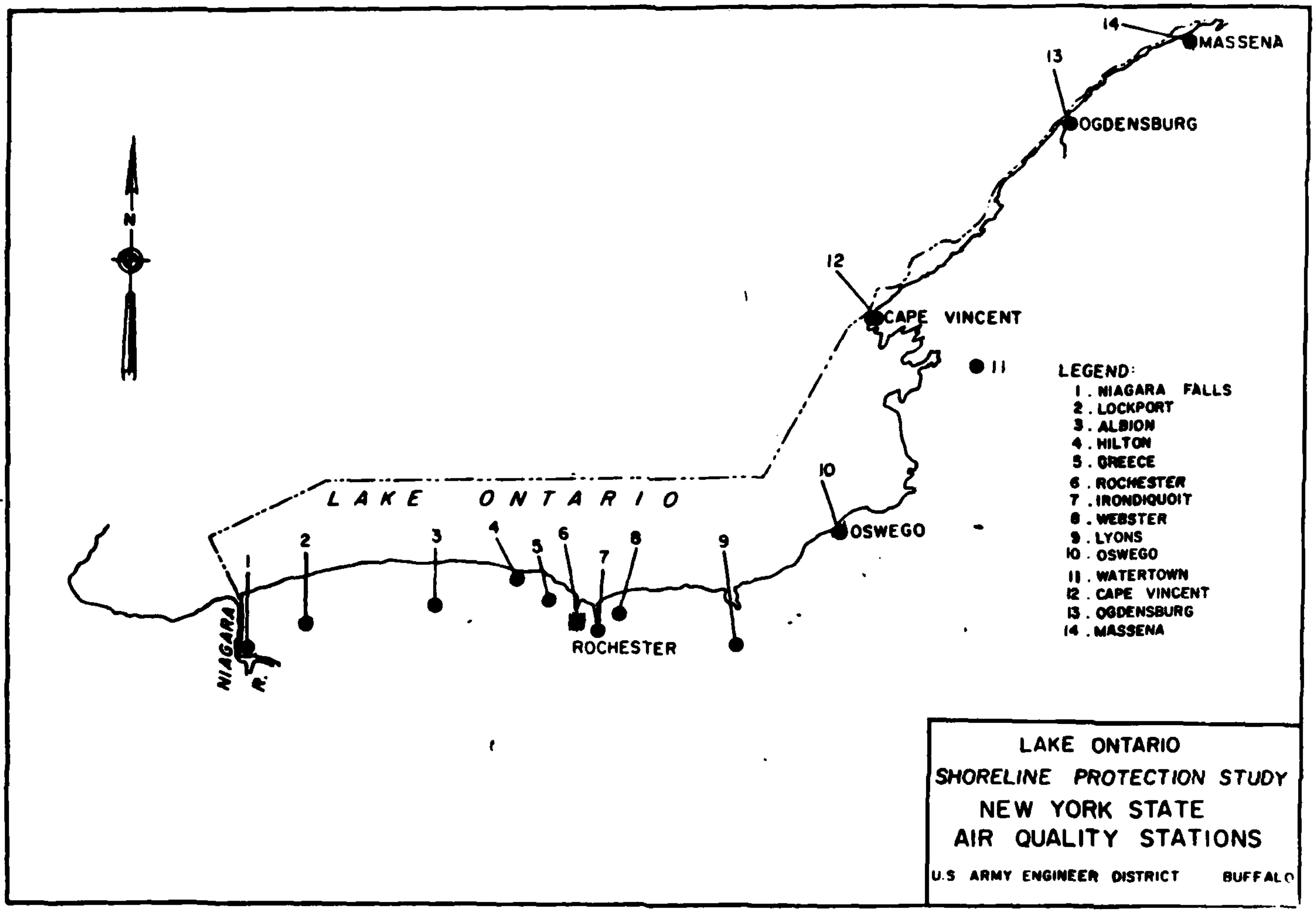

N
MASSENA
OGDENSBURG
CAPE VINCENT
OSWEGO
ROCHESTER
NIAGARA R.
LAKE ONTARIO
LEGEND:
1. NIAGARA FALLS
2. LOCKPORT
3. ALBION
4. HILTON
5. GREECE
6. ROCHESTER
7. IRONDIQUOIT
8. WEBSTER
9. LYONS
10. OSWEGO
11. WATERTOWN
12. CAPE VINCENT
13. OGDENSBURG
14. MASSENA
LAKE ONTARIO
SHORELINE PROTECTION STUDY
NEW YORK STATE
AIR QUALITY STATIONS
U.S ARMY ENGINEER DISTRICT BUFFALO

Figure 2.13a

"The nitrogen content of Lake Ontario, measured by the spring concentrations of nitrate plus nitrite, is still increasing. However, the incremental increase during 1977-78 is much smaller than the mean yearly increase of 11 ug/L during the period 1969-77. Trend analysis was performed on data from both 1 m and 40 m depths; statistical analysis indicated an excellent fit for the data and the increases found from 1969 to 1978 are statistically significant ($P<0.05$).

"Chloride concentrations increased from 7 mg/L in 1907 to 26 mg/L in 1966 and 28.5 mg/L in 1971. However, since 1972, there has been no increase in chloride levels. This recent stabilization of chloride concentration in Lake Ontario is probably attributable to the recent extended above-average levels of the lake. Thus, the loading and discharge of chloride to and from Lake Ontario would appear to have reached an input-output equilibrium. This implies that, if future loadings remain constant, the chloride concentration in the lake will rise and fall inversely with the water level (and hence the volume) of the lake.

"Specific conductance data can be used for the same purposes as chloride. However, the usefulness of these data is limited by the fact that some of its ionic components (notably Ca^{+2}, HCO_3^{+2} and Mg^{+2}) undergo a seasonal variation which often is larger than its year to year or areal differences in the lake. Hence, only data from the spring cruises are used in the trend analysis. Over the last 7 years, no trend can be established. The specific conductance has ranged between 320 and 340 microsiemens at 25°C. Using a specific conductance to total dissolved solids (TDS) conversion factor of 0.62, the TDS levels in Lake Ontario are in violation of the 200 mg/L 1978 Water Quality Agreement Objective.

"Chlorophyll _a_ data in 1978 were obtained with a 0-20 m integrator from 95 stations on nine cruises. Chlorophyll _a_ lakewide mean values increased from March to July, and then remained at a constant level throughout the rest of the sampling period. The highest chlorophyll _a_ readings were obtained on the last cruise in November, indicating that the entire seasonal cycle was not sampled.

"Phosphorus loadings to Lake Ontario during 1978 were estimated to be 5,693 tons/year. Compared to 1976 and 1977 loadings of 7,082 tons/year and 6,187 tons/year, there has been relatively little change in nutrient loadings. The decreases in lakewide concentrations are, therefore, not a direct response to remedial loading control programs.

"Mean concentrations of DDT exceeded the Agreement objective of 1.0 ug/g in whole fish for lake trout, rainbow trout, and coho salmon. The Agreement objective of 0.1 ug/g for PCB residues in whole fish was exceeded in each of the five species analyzed. Mean concentrations of mirex in smelt, lake trout, rainbow trout, and coho salmon exceeded the Agreement objective of 0.1 ug/g in whole fish. There has been essentially no change in residues of PCBs or mirex since these compounds were banned.

"Declines in residues of PCBs, DDE, HCB, and mirex are evident on Lake Ontario herring gull colonies monitored between 1974 to 1978. Constant rates

of decline were statistically valid for mirex and DDE over the 5-year period. The rate of decline for mirex is much faster than originally considered possible by many experts. Since mirex loadings were limited largely to one major source at Niagara with a secondary source at Oswego, this is possibly an example of improvement in ecosystem quality due to contaminant abatement. Other residues such as PCBs and HCB show similar trends. Since 1974, the increase in reproductive success in herring gulls has paralleled the decline in the major organochlorine residues (IJC, 1979b)."

2.10.2 NEAR SHORE ZONE

The near shore waters of Lake Ontario are, like the open water, Class A with the exception of the Rochester embayment, Oswego Harbor, and the Black River embayment (NYSDEC, Title 6, Vol. B-F). Class A waters are suitable as a drinking water source. The Rochester embayment is Class B allowing primary contact recreation while Oswego Harbor and Black River embayment are Class C suitable for fishing but not for primary contact recreation or as a drinking water source.

Another nearshore area extending from the mouth of the Niagara River to Eighteenmile Creek has exhibited high total coliform values (IJC, 1979a, b). Specific information on the problem areas above is listed in Table 2.14.

2.10.3 ST. LAWRENCE RIVER

"In 1977, six IJC sponsored surveys were conducted between April and October to measure the concentrations of nutrients, major ions, heavy metals, and organics in the surface water of the International Section of the St. Lawrence River. Major ions and metals were measured on alternate surveys; persistent contaminants were measured twice at 12 selected stations.

"There were no significant changes in the phosphorus levels between 1973 and 1977. Average phosphorus concentrations remained around .020 mg/L, approximately .003 mg/L higher than the 1977 eastern Lake Ontario mean of .017 mg/L. Total phosphorus concentrations downstream from Brockville to Cornwall were generally higher than upstream values. This pattern was noted in each survey.

"Average specific conductance for the St. Lawrence River in 1977 was 315 microsiemens. Mean specific conductance during the period 1968 to 1973 varied between 317 to 326 microsiemens indicating no significant change in dissolved solids. Using a conversion factor of .65, total dissolved solids in the St. Lawrence River in 1977 was 204 mg/L, just exceeding the Agreement objective of 200 mg/L. There was no noticeable downstream trend in specific conductance, although some river stations located immediately downstream from tributary stations registered a lower specific conductance due to dilution.

"The chloride concentrations in the St. Lawrence River ranged from 25.8 to 28.1 mg/L. These readings compared well with values of 27.6 - 28.5 mg/L reported in 1969 to 1973.

Table 2.14 - Problem areas in Lake Ontario and St. Lawrence River 1/

Problem Area Determined by Field Surveys in Boundary Waters			Discharges of One or More of the Substances Identified in the Problem Area Individual Discharges may be Currently in Compliance with Agency Requirements				Assessment of Whether or Not Completion of Remedial Programs for the Identified Will Correct the Problem
Location	Problem-Violation Objective or Standard	Date-Last Survey	Name of Discharger	Jurisdiction	Substances Discharged	Status of Remedial Programs	
Lake Ontario 2/ Shoreline from mouth of Niagara River to Eighteen-mile Creek	Total coliform	1976	Municipal discharges to the Niagara River are contributing to water quality problems along the Lake Ontario Shoreline.	New York Ontario	Source of coliform	Direct discharges from municipal treatement plants in Niagara-on-the-Lake and two plants in St. Catharines are satisfactory.	Combined sewer overflows, which generally have longer range abatement schedules, will continue to cause problems during rainfall periods.
Rochester 2/ Embayment	Coliform	1977	Irondequoit STP	New York	Source of coliform	Being served by Rochester Frank Van Lare STP. Phased out October 1978.	Yes
			Rochester, Frank Van Lare STP	New York	Source of coliform	Met effluent requirements.	Yes
			Rochester, Combined sewer overflows	New York	Source of coliform	Abatement measures under study.	Combined sewer overflows which generally have longer range abatement schedules, will continue to cause problems during rainfall periods.
Oswego Harbor 2/	Chloride, nitrate	1977	Oswego East Side STP	New York	Probable source of chloride, nitrate	Met effluent requirements. Requested 301(i) extension to prepare industrial waste ordinance.	Yes
			Oswego West Side STP	New York	Probable source of chloride, nitrate	Secondary facilities completed late 1978.	Yes
			Miller Brewing Co., Oswego	New York	Probable source of nitrate	Met effluent requirements.	Yes
			Oswego Combined sewer overflows	New York	Probable source of chloride, nitrate	Abatement measures under study.	Combined sewer overflows, which generally have longer range abatement schedules, will continue to cause problems during rainfall periods.
			Natural drainage	New York	Source of chloride, nitrate	Natural geological conditions and land runoff from the Seneca-Oneida-Oswego River Basin.	Natural conditions are the primary cause of problems.

Table 2.14 - Problem Areas in Lake Ontario and St. Lawrence River 1/ (Cont'd)

Problem Area Determined by Field Surveys in Boundary Waters			Discharges of One or More of the Substances Identified in the Problem Area Individual Discharges may be Currently in Compliance with Agency Requirements				
Location	Problem-Violation Objective or Standard	Date-Last Survey	Name of Discharger	Jurisdiction	Substances Discharged	Status of Remedial Programs	Assessment of Whether or Not Completion of Remedial Programs for the Identified Will Correct the Problem
Black River 3/	Eutrophic conditions	1973		New York		Large inputs of phosphorus from Black River result in the eutrophic conditions. Sewage treatment plant near the mouth of Black River may contribute to problem.	Unknown
Grass River 2/ (St. Lawrence River)	PCBs	1977	Under investigation	New York	PCBs	Ban use of PCBs.	Unknown
Ogdensburg 3/	Poor mixing of municipal discharge - coliform bateria anticipated		City of Ogdensburg	New York			Unknown

1/ Adopted from IJC, 1979a.

2/ An area where further remedial programs may be required.

3/ Source - NYSDEC 1977, 1980.

"Most of the metal concentrations found in the St. Lawrence River were in trace quantities and well below the new Agreement objectives for metals. One common feature of the spatial variations of zinc, iron, and aluminum is the high concentration of metals found downstream of Cornwall by the Grass River, the Raquette River, and the St. Regis River. The average aluminum concentration found downstream from the Grass River was .090 mg/L, about three times higher than the upstream background concentration. The maximum aluminum concentration detected was 0.200 mg/L at the mouth of the Grass River. Spatial distribution of iron was almost identical to that of aluminum. Average iron concentration downstream from the Grass River was about .160 mg/L, while the background concentration was about .060 mg/L. Concen-trations of .400 to .440 mg/L (exceeding the objective of .300 mg/L) were recorded just downstream of the Grass River and the Raquette River. Although the concentration differences were smaller, the high metal concentrations found at these river mouths suggest that these rivers are sources of metal contamination (IJC, 1979b)."

"Water samples were collected at 12 selected locations in June and August 1978 for analysis of persistent organic contaminants. These included polychlorinated biphenyls (PCBs), mirex, organochlorine pesticide residues, and some chlorinated hydrocarbons. In all the tests, lindane and hexachlorocyclohexane (BHC) were detected over the stretch of the river. The levels of BHC were in the range of .003 - .008 ug/L. Lindane concentrations ranged from .003 - .007 ug/L (the Agreement recommended level for lindane in water is 0.010 ug/L). PCBs were detected only at the mouth of the Grass River in concentrations of 0.18 ug/L and 0.06 ug/L (IJC, 1979b)." This area has been added to the problem area list in Table 2.14. Except for an area of municipal discharge at Ogdensburg, the St. Lawrence River is categorized Class A (NYSDEC, Title 6, Vol. B-F).

2.11 PRIME AND IMPORTANT FARMLAND

Consideration must be given to important farmlands and the long-range need to retain the productive capability and environmental values of New York State's agriculture. Such consideration should include the category of prime farmlands that may exist near the Lake Ontario Shoreline.

Prime farmland is that farmland best suited for producing food, feed, forage, fiber, and oil seed crops - and also available for these uses. The land could presently be cropland, pastureland, forest land or other land, but not urban land or water. The rationale for this approach is that land committed to irreversible uses may not be available for cropping. Actions that put high quality farmland in irreversible uses should be initiated only if the actions proposed are clearly in the public interest. In general, prime farmland has the soil quality, growing season and moisture supply needed to produce sustained yields of crops economically when treated and managed, including water management, according to modern farming methods.

It should be further recognized that according to the New York State Coastal Management Program Report published in March 1979, important farmland is defined as "1) those lands which meet the United States Soil Conservation Service's criteria as being prime, unique, or of Statewide importance;

2) active farmland within Agricultural Districts; or 3) agricultural areas identified as having high economic viability."

Figure 2.14, extracted from maps prepared in August 1977 by the U. S. Soil Conservation Service (SCS), provides a broad overview of the approximate location of prime farmlands and other lands considered to be of Statewide importance near the Lake Ontario shoreline.

2.12 VEGETATION

Both terrestrial and aquatic vegetation are found along the Lake Ontario-St. Lawrence River coastline. Forestland, managed agricultural fields and abandoned fields in various stages of natural plant succession are interspersed along terrestrial areas of the shoreline. The littoral zone - that marginal part of water along the immediate shoreline of islands and the mainland, that extends outward from shore to about a depth of 6-7 meters (the approximate limit of rooted vegetation) - includes important aquatic areas containing shallow bays, tributaries and wetlands that have a variety of submergent, floating and emergent plants.

2.12.1 TERRESTRIAL

Natural terrestrial vegetation patterns along the Lake Ontario-St. Lawrence River coastline have been influenced by man's land use activities. Many land areas previously forested have been replaced by urban, industrial and agricultural development. Viewed on a broader scale, from the standpoint of "*Ecoregions of the United States*" (Bailey 1978), the aforementioned coastal zone lies within the northern hardwoods forest section - a subdivision of the Laurentian Mixed Forest Province, characterized as transitional, lying between the boreal and deciduous forest zones. This section consists of either mixed stands of a few coniferous (mainly pine) and a few deciduous species, or a mosaic-like arrangement with pure deciduous forest on less favorable habitats that have poorer soils. Oak, hickory, maple, beech, and birch are among the deciduous trees found in the area, whereas white pine, eastern hemlock, and spruce are the main trees found in the coniferous (evergreen) group. The more northerly shallow soils of Niagara, Orleans and Monroe Counties near the coastline support growths of white oak, northern red oak, and hickory trees.

The western portion of the Lake Ontario terrestrial shorelands from about Oswego County to Niagara County contains much cropland utilized for growing fruit and vegetables. Some of these fields are devoted to grain-grass crop rotations involving production of such plant species as corn, oats, wheat, birdsfoot treefoil, alfalfa, timothy, and clover.

The St. Lawrence-Eastern Ontario Study (Geis and Luscomb 1972) describes six natural vegetation types - wetlands, and the following five terrestrial types:

a. Disturbed areas consisting of:

(1) agricultural lands planted to hay, pasture, grain and grass crops.

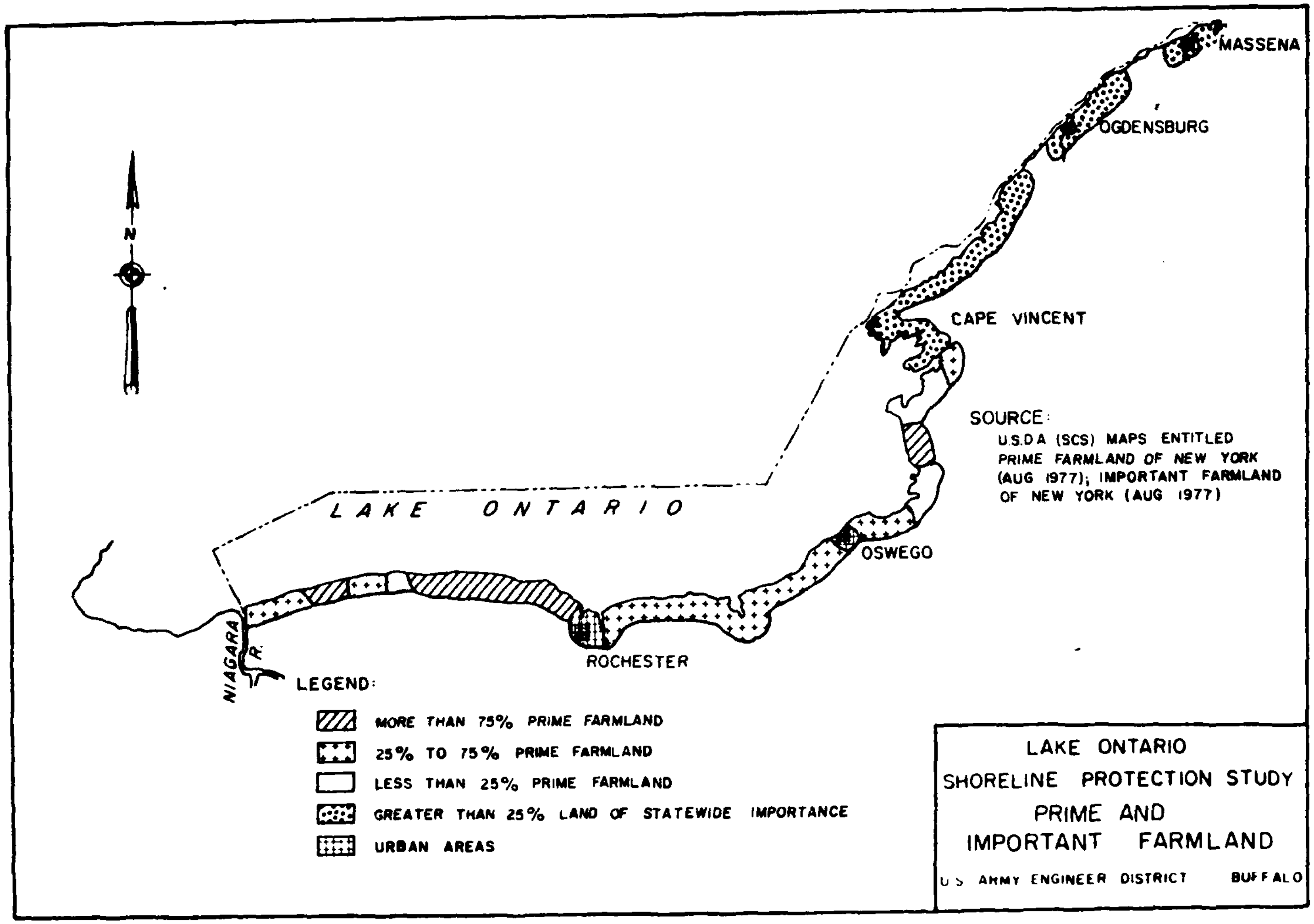

MASSENA
OGDENSBURG
CAPE VINCENT
SOURCE:
U.S.D.A (SCS) MAPS ENTITLED PRIME FARMLAND OF NEW YORK (AUG 1977); IMPORTANT FARMLAND OF NEW YORK (AUG 1977)
OSWEGO
LAKE ONTARIO
ROCHESTER
NIAGARA R.
N
LEGEND:
MORE THAN 75% PRIME FARMLAND
25% TO 75% PRIME FARMLAND
LESS THAN 25% PRIME FARMLAND
GREATER THAN 25% LAND OF STATEWIDE IMPORTANCE
URBAN AREAS
LAKE ONTARIO
SHORELINE PROTECTION STUDY
PRIME AND
IMPORTANT FARMLAND
U.S. ARMY ENGINEER DISTRICT BUFFALO

Figure 2.14

(2) developed lands that include residences, marinas, business, roads, gravel pits, and areas of human disturbance.

b. Successional fields characterized by abandoned agricultural lands reverting to herbaceous nonwoody plant species, open shrubby fields or shrublands.

c. Forests, which are classified into the following five basic cover types:

(1) deciduous forests;

(2) coniferous forests;

(3) mixed forests;

(4) successional forests; and

(5) plantations.

d. Rock outcrop vegetation adapted to drier sites that contain herbs and shrubs or predominantly trees and shrubs.

e. Dune complex, containing natural plant communities that are composed of species adapted to extremes of surface instability and environmental severity. Natural dune vegetation is considered to be unique along the coastal zone under consideration.

2.12.2 AQUATIC

The littoral zone, which in general extends outward from shore to a depth of about 6-7 meters, also includes shallow bays and wetlands and the immediate shoreline subject to high and low water level fluctuations. This zone contains a variety of emergent, surface, and submergent plant life-forms. As defined by Golet and Larson (1974), "emergent" refers to rooted herbaceous or semiwoody plants that have the majority of their vegetative portion above the water; "surface vegetation" refers to floating-leaved vegetation (nonrooted plants that float freely on the water surface); and "submergent" pertains to plants that grow beneath the water surface. Except for flowering parts in some species, most of the aquatic plants are rooted. Using Resource Publication 116 (Golet and Larson 1974), the publication on coastal wetlands along Lake Ontario and the St. Lawrence River in Jefferson County, NY, (Geis and Kee 1977) and the USDI ecological report on Biological Characteristics of the St. Lawrence River (1976) as general guides, the following are some of the aquatic plant life-forms expected to be present in the glaciated northeast, within which the study area is located.

a. Emergents.

(1) Subshrubs (emergents up to 5 feet tall having a semiwoody base, growing in water up to 18 inches deep) - water willow (Decoden verticillatus) and buttonbush (Cephalanthus occidentalis)

(2) Robust emergents (stout, erect emergents 5 to 10 feet tall) - cattail (Typha glauca), T. latifolia, T. angustifolia)

(3) Tall meadow emergents (grass-like emergents up to 6 feet tall, found on moist or seasonally flooded soil) - reed canary grass (Phalaris arundinaceae), bulrush (Scirpus spp.), wild millet (Echinochloa spp.)

(4) Short meadow emergents (sedge-like emergents less than 4 feet tall, found on moist or seasonally flooded soil) - rush (Juncus spp.), sedge (Carex spp.), galingale (Cyperus spp.)

(5) Broad-leaved marsh emergents (broad-leaved emergents less than 3 feet tall, growing on moist soil or in water up to 18 inches deep) - arrow-arum (Peltandra virginica), arrowhead (Sagittaria spp.), smartweed (Polygonum, spp.) water plantian (Alisma triviale).

b. Surface vegetation.

(1) Floating-leaved vegetation - white water lily (Nymphaea tuberosa), spatterdock (Nuphar spp.), pondweed (Potamogeton spp.)

(2) Floating vegetation - big duckweed (Spiradela polyrhiza), small duckweed (Lemna minor), liverwort (Riccia flucitans).

c. Submerents.

Waterweed (Elodea canadensis), coontail (Ceratophyllum demersum), bushy pondweed (Najas flexilis), water milfoil (Myriophyllum spp.), wild celery (Vallisneria americana), muskgrass (Chara vulgaris), bladderwort (Utricularia spp.), algae (Cladophora glomerata).

With regard to "wetlands," the term itself refers to those areas inundated by surface or groundwater, with a frequency sufficient to support, and under normal circumstances does, or would support, a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. "Wetlands generally include swamps, marshes, bogs and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats and natural ponds" (Executive Order 11990, 1977). It is difficult to define wetlands without reference to the vegetative characteristics. Cowardin et al (1976) point out that certain wetlands may be non-vegetative due to disruptions such as wave actions, water currents, turbidity, and water level fluctuations, but that vegetation would predictably develop in those units if the disruptions were not present. This concept is included in the definition of the term "wetland" found in Executive Order 11990.

In emphasizing the importance of wetlands found in the coastal zone ecosystem, it is important to keep in mind that wetland plant communities help form the transition zone between water and land environments and perform a number of vital natural functions. As recognized in the environmental inventory section of the Erie and Niagara Counties Regional Planning Board report on Section 208 water quality managment (1978), wetlands "affect water

quality by filtering out silt and other pollutants, slowing down runoff, and changing inorganic nutrients into acceptable nutrient material. Wetlands also serve to stabilize water quality by absorbing excess flows during flood periods and retaining it during droughts. Additionally, wetlands are particularly important for maintenance of existing fish and wildlife habitat along the Lake Ontario-St. Lawrence River Shoreline. They provide critical breeding, nesting and feeding grounds for fish, birds, and other aquatic organisms and contribute to food chains of upland plants and animals." Finally, "wetlands may function as recharge areas for groundwater, groundwater discharge areas, or catch basins for overland flow." Recognizing the high natural value of freshwater wetlands and that wetlands are rapidly being destroyed, New York State passed the Freshwater Wetlands Act in 1975. This Act regulates activities on wetlands of 12.4 acres or more in size, as well as activities on lands within 100 feet of the vegetative boundary of a wetland.

Fluctuating water levels are one of the most important environmental factors affecting wetland plant communities within the Great Lakes-St. Lawrence River Basin. Geis, in his recent paper on Shoreline Processes Affecting the Distribution of Wetland Habitat (spring 1979) stresses - "several lines of evidence suggest that water levels represent the single most important variable in defining the extent, species composition, and stability of coastal wetlands along Lake Ontario and the St. Lawrence River," and that this conclusion has frequently been stated in other contexts such as Gosselink and Turner (1978) and Weller (1978). Geis also mentions that wetland studies carried out by the SUNY College of Environmental Science and Forestry, Syracuse, NY, "suggest that coastal wetlands are intricately tuned to the water regime during both the dormant and growing season. Modifications in water regime, induced by either production and competitive dynamics; distributional shifts in wetland communities through the die-off of components of the wetland continuum and temporary niche filling by other species; modification of winter snow and ice covers with implications for both plant and animal tendencies for habitat disruption due to the extreme sensitivity of the contact zone between wetlands and shallow water during winter." Affect on wetlands from water level changes is also mentioned in the U. S. Fish and Wildlife Service report on ecological studies - <u>Biological Characteristics for the St. Lawrence River</u> (1976) which states, "wetlands represent unique biotic systems for a variety of biological reasons. Their species composition is dependent upon the prevailing character of the water regime; moreover great changes in composition can occur with short distances across this gradient as a result of the interaction of land elevation and water levels. Minor changes in mean annual water levels, yearly maximums or minimums, or the amount and timing and drawdown can result in major compositional adjustments."

While sometimes appearing to have negative impacts, water level fluctuations are often necessary to maintain long-term health of wetlands. These are called "pulse-stable" communities (Institute of Environmental Studies 1976). The community oscillates between hydric (moisture abundance) and xeric (deficient moisture) conditions, never completing a successional climax from open water to upland community. Extreme high water levels, such as those which occurred during the early 1950's and the early 1970's tend to

kill off species less tolerant of inundation: emergent species die off and give way to submergent zones; shrubs and trees along the upland border die off and give way to emergents and wet meadow species. Extreme low levels - such as during the 1930's and 1960's - allow the return of earlier vegetation patterns, but if the low levels remain for extended periods, upland species encroach upon the wetland. Areas of die-off along the St. Lawrence during the 1972-74 period of high water partially recovered by the 1976 growing season, (Geis and Kee 1977).

2.13 FISH RESOURCES

The Great Lakes-St. Lawrence River Basin contains a variety of fish species and subspecies, many of which entered the lakes during the Pleistocene glaciation period. Exotic species (i.e., white perch) are also present in the basin system due to introduction by man - either purposely or inadvertently. These introductions, along with selective overfishing of some species (i.e., Atlantic salmon), clearing of forested areas in the watershed and possibly other environmental factors, have led to significant changes in fishery resources of the Basin.

Prior to the 1920's, lake sturgeon, lake herring, whitefish, and walleye were among the species highly sought by fishermen. However, by the 1920's, these species declined; walleye showed gradual decline during this period (Schneider and Leach 1979). Decline of these fish species led to heavier utilization of large predatory fish such as lake trout and blue pike. Blue pike were once common at the east end of Lake Ontario, where about one-fourth of the New York commercial catch was taken (Rathbun and Wakeham 1898). Since the 1930's, lake trout, whitefish, blue pike, and lake sturgeon stocks in Lake Ontario have either been eliminated or drastically reduced, while populations of carp, white perch, smelt, and alewives have increased (USDI 1969).

The St. Lawrence-Eastern Ontario Commission's Report on coastal resourcs (1977) indicates that "the single most valuable biotic resource of eastern Lake Ontario is the areas fishery. Its numbers and variety of fish support both sport and commercial fishing enterprises." In general, the St. Lawrence- Eastern Ontario region harbors a major portion of the fisheries resources of New York State (SUNY Technical Report 1972) - this includes cold and warm water fish species. New York State stocked coho salmon in the Salmon River watershed in 1968 and in Lake Ontario in 1969; chinook salmon fingerlings were stocked in the Little Salmon River watershed in 1969; Kokanee salmon were introduced in the lake and in some tributaries by the Province of Ontario and splake were introduced in the lake by the Province of Ontario in 1969. With regard to warm water fish, the ten most important fish species harvested in 1975 (based on value) were bullheads, yellow perch, American eel, white perch, rainbow smelt, sunfish, rock bass, crappies, suckers, and catfish (St. Lawrence-Eastern Ontario Commission 1977). Other species of importance to the region's fishery include smallmouth bass, northern pike, muskellunge, white bass, largemouth bass, and walleye.

Inshore areas and tributary streams provide important spawning and nursery habitat for several forage species such as alewife, slimy sculpin, rainbow smelt, and minnows. The Great Lakes Basin Framework Study (Great Lakes

Basin Commission 1975) points out the importance of inshore areas by mentioning that: "Within the littoral zone biological production is at its peak, and fluctuations have their greatest effects." The study further states "based on the analysis of all present biological data, fisheries favor high stable levels in order to increase the littoral productive area and thereby enhance the total fishery resource."

As general guidance, Table 2.15, extracted from the St. Lawrence-Eastern Ontario Commission's technical report on the area's fishery resources, provides some basic information on life histories of various sport and commercial warm and cold water fish species inhabiting the area.

2.14 AQUATIC RESOURCES (BENTHOS, PHYTOPLANKTON, ZOOPLANKTON)

2.14.1 BENTHOS

A profile of Lake Ontario benthos shows that the fauna is qualitatively uniform (IJC, 1969). Most samples show that 95 percent of the organisms present are either the amphipod, *Pontorporeia affinis* or segmented worms of the class Oligochaeta. Oligochaetes are represented in freshwater by four primary families, Enchytraeidae, Lumbriculidae, Naididae, and Tubificidae (Hiltunen 1964, IJC 1969, Judd and Gemmel 1971, Thomas 1976).

It should be noted that another amphipod, *Gammarus fasciatus* is also present in large numbers and at times is present in greater concentrations than *Pontoporeia affinis*. (Thomas 1976). *Gammerus* and *Pontoporeia* are a vital food source for many fish species in Lake Ontario and were found to be primary food sources in sampled white perch, rock bass and yellow perch (U. S. Fish and Wildlife Service 1978).

The oligochaetes dominate the macrobenthos of Lake Ontario in terms of density (Judd and Gemmel 1971), and densities of 500-1,000 organisms per square meter are not unusual (IJC 1969). A representative sample of organisms found along the shoreline would include *Stylodrilus heringianus* of the family Lumbriculidae. This species is common throughout the lake and is usually associated with relatively pollution-free areas. The family Tubificidae, contributed the largest number of sampled species, of which *Limnodrilus hoffmeisteri*, was the most common oligochaete found in Lake Ontario (Hiltunen 1964). Other common species found throughout the lake are *Potamothrix moldaviensis*, *P. vejdovskyi* *Peloscolex fexox* and *Tubifex tubifex*. (Hitunen 1964, Thomas 1976). The Oligochaetes are distributed throughout Lake Ontario, but their density varies. Concentrations are high near the mouths of large rivers. These organisms seem to thrive in such locations. Many Oligochaetes are referred to as sludge worms and are associated with polluted sediments. (Hiltunen 1964; IJC 1969).

The remaining 5 percent of the benthic community is comprised of Sphaeriidae, genus *Pisidium* (fingernail clam), Diptera, family Chironomidae (larval midges) Isopoda, (aquatic sow bug), Hirudinea (leeches), and Gastropoda (snails) (IJC 1969; Casy, Fisher, Kleveno, 1973).

Table 2.15 - Life History Summary of Major Coldwater and Warmwater Sport and Commercial Fish in Eastern Lake Ontario and St. Lawrence River (Scott & Crossman 1973, SLEOC 1978)

Species	Adult Habitat Spring	Adult Habitat Summer	Adult Habitat Fall/Winter	Adult Food Supply	Spawning Period	Spawning Habitat	Young Habitat	Young Food Supply
American Eel	Shallow inshore waters	Inshore areas in vegetation and mud	Inshore areas buried in mud	Fish and invertebrates	Fall	Vicinity of Sargasso Sea	Drift in ocean for a year	Unknown
Brown Bullhead	Shallow bays, slow moving rivers	Shallow bays and streams	Open bays	Insects, leeches, worms, plant materials	April to June	Mud or sand in shallow water of lake and streams	Same as adult	Same as adult
Carp	Weedy shallows	Slow moving waters	Slow moving waters	Plant and animal tissue	Spring and early summer	Weedy or grassy shallows	Same as adult	Same as adult
Lake Sturgeon	Shoal areas	Shoal areas and deeper water	Moderate depths	Small organisms found on the bottom	Early May to late June	Swift water or wave washed areas	Same as adult	Invertebrates, some plant life
Largemouth Bass	Shallow bays	Upper waters of slow moving rivers	Bottom areas, somewhat active in winter	Fish, insects, frogs, and crayfish	Late spring to mid-summer, usually prior to smallmouth	Quiet bays among emergent vegetation	Same as adult	Invertebrates
Muskellunge	Wetlands, weedy bays	Weedy bays, slow moving rivers	Weedy bays, slow moving rivers	Vertebrates, mainly fish	Late April to early May	Shallow wetland areas, weedy bays	Remain near spawning ground until July	Zooplankton, fish after 3 to 4 weeks
Northern Pike	Shallow weedy areas of creeks, wetlands	Weedy bays, slow moving rivers	Weedy bays, slow moving rivers	Vertebrates, mainly fish	April to early May	Shallow wetland areas, weedy bays	Remain near spawning ground; move out in July	Zooplankton, fish after one week
Pumpkinseed	Shallow inshore waters	Cover of submerged vegetation	Cover of submerged vegetation	Insects and other invertebrates	Late spring to early summer	6-12" of water along lakeshore w/vegetation	Same as adult but with more vegetation	Same as adult
Rock Bass	Shallow inshore waters	Shallow water, associated with bass	Shallow water, associated with bass	Aquatic insects, crayfish, small fish	Spring to early summer	Inshore gravel bottom areas	Same as adult but with more vegetation	Same as adult
Sea Lamprey	Estuaries and streams	Deep water as parasite	Stream or lake	Parasitic on fish	June	Tributary streams	Pool areas in streams	Minute plant and animal material
Smallmouth Bass	Shallow inshore waters	Seek deeper water	Bottom areas, inactive in winter	Insects, crayfish, fish	Late May to early June	Shallow gravelly bottom areas of lake river and some streams	Same as adult	Insects, crayfish by the time they reach 50mm in length
Walleye	Spring run to shallow shoals or tributary rivers	Large streams, rivers, lakes. Seek turbid water and other shields from sunlight	Same as summer but avoid strong currents	Fish, adult insects	Spring, shortly after ice breks up	Rocky areas in white water or gravel shoals in lakes	Near bottom in 30-40 feet of water	Invertebrates and fish
White Perch	Shallow inshore waters	Move inshore at night and to deeper water	School in lake	Fish, emphipods	Mid-May through June	Most shallow areas	Same as adult	Microlankton, invertebrates
Yellow Perch	Shallow inshore waters	Open lake in areas of moderate vegetation (under 30 ft. deep)	Under 30 ft. depth, school in lake, active all winter	Insects, crayfish, fish	Mid-April to May	Shallows of lake and and tributary rivers	Shallow water near vegetation	Insects, invertebrates
Brown Trout	Very close to shore	Move just offshore in preferred temperature range	Move inshore with cooling temperature; congregate in shallow bays and streams	Alewife, insects	Late fall to early winter	Shallow, gravelly headwaters	Same as adult in the lake	Aquatic and terrestrial insects and larvae, crustaceans

Table 2.15 - Life History Summary of Major Coldwater and Warmwater Sport and Commercial Fish in Eastern Lake Ontario and St. Lawrence River (Cont'd)

Species	Adult Habitat Spring	Adult Habitat Summer	Adult Habitat Fall/Winter	Adult Food Supply	Spawning Period	Spawning Habitat	Young Habitat	Young Food Supply
Chinook Salmon	Scattered throughout open lake	Open lake where thermocline meets bottom	Move inshore to spawning streams, spawn and die	Smelt, alewife, invertebrates	September [illegible] December	Parent strea[illegible] large[illegible] or tr[illegible]aries	Move to the lakes as fingerlings during first summer	Invertebrates, mainly insects
Coho Salmon	Inshore at first, later moving offshore into the open lake	In the open lake, schooling at the thermocline	Move inshore to parent streams, ascend streams to spawn and die	Smelt, alewife, invertebrates	Late August through October	Pare[illegible] streams, shallow, gravelly areas of tri[illegible]aries	Remain in streams until smolt stage, move into lake [illegible]ring second spring	Aquatic insects and larvae, small fish
Lake Trout	Move inshore, but away from shallows	Below thermocline	Move shoreward during fall	Alewife, smelt, sculpin	October through November	Rocky shoals at depths less than 120 feet	Seek deep water within one month	Sculpin
Rainbow Trout (Steelhead)	Close to shore, in and near spawning streams	Scattered throughout lake in thermocline area	Move inshore in fall; some ascend streams with salmon	Bottom invertebrates, plankton, forage fish	Late February to early May	Tributary streams with fine gravel areas	Move to lake immediately or remain 1 to 2 years in the stream	Crustaceans and other bottom invertebrates

There is another group of organisms that are plentiful and usually found throughout Lake Ontario. A division of the class Crustacea is Peracarida. There are many orders in this division, one being Mysidacea. This order has over 400 species and the most widely distributed freshwater mysid is Mysis relicta (Hutchinson 1967). This species is associated with Oligotropic conditions (International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence Water Pollution Board, 1969), and at specific locations in Lake Ontario, can even account for 60 percent of a sample (Thomas 1976). Mysis relicta, even though present in many samples throughout the lake, seem to be most predominant at approximately 5 miles from shore (International Lake Erie Water Pollution Board and the International Lake Ontario St. Lawrence Water Pollution Board 1969, Sweeney 1973).

The benthic flora of the nearshore zone of Lake Ontario is dominated by Cladaphora. This is a filamentous green algae not found in sand or other unconsolidated strata. This algae is usually found in greatest quantity in 1 to 5 meters of water (Sweeny 1973, Thomas 1976) and its biomass is closely related to fluctuations in water levels. Lower water levels will permit more rock to be utilized as a potential substrate for Cladophora development. Known areas of high concentrations are indicated on Figure 2.15.

Cladophora is also associated with various chironomids and mysidse. These insects and crustaceans utilize the algae in various ways. Cladophora is considered an important element of their life cycle (Rochester Gas & Electric 1976). This algae can also cause serious problems by fouling water supplies, interfering with fish nets and causing large financial losses due to degradation of aesthetics and recreation. Obnoxious conditions occur frequently when in July, Cladophora builds up in nearshore areas and decomposes (IJC 1969).

Many benthic studies have been performed at numerous specific sites along Lake Ontario. These studies have compiled inventories of both flora and fauna. The data from these site specific areas is very similar in nature to the overall view presented in this section. At various sites, pollution tolerant species of midge larva, did constitute a higher percentage of the benthic samples along with Oligochaeta than other previously mentioned species of amphipods. Examples of these chironomids are Chironomus, spp., Procladius spp., Cryptochironomus spp. (Ellis, Haines, Makarewicz 1977).

The St. Lawrence River has not been extensively studied. The region of Ogdensburg was surveyed and the data revealed that approximately 50 percent of the benthos was Oligochaeta, 21 percent Amphipoda, 18 percent Diptera, and 3 percent Pelecypoda (Corps 1979). This inventory still appears to indicate probable dominance by Oligochaetes and Amphipods.

2.14.2 PHYTOPLANKTON

Lake Ontario is characterized as being an oligotrophic to mesotrophic lake (Ogawa, 1964; Thomas, 1976). Presently, this condition is changing due to increasing amounts of organic matter. Lake Ontario is becoming eutrophic along nearshore tributaries and in various embayments. This enriched condition is reflected by the dominance of phytoplankton taxa indicative of

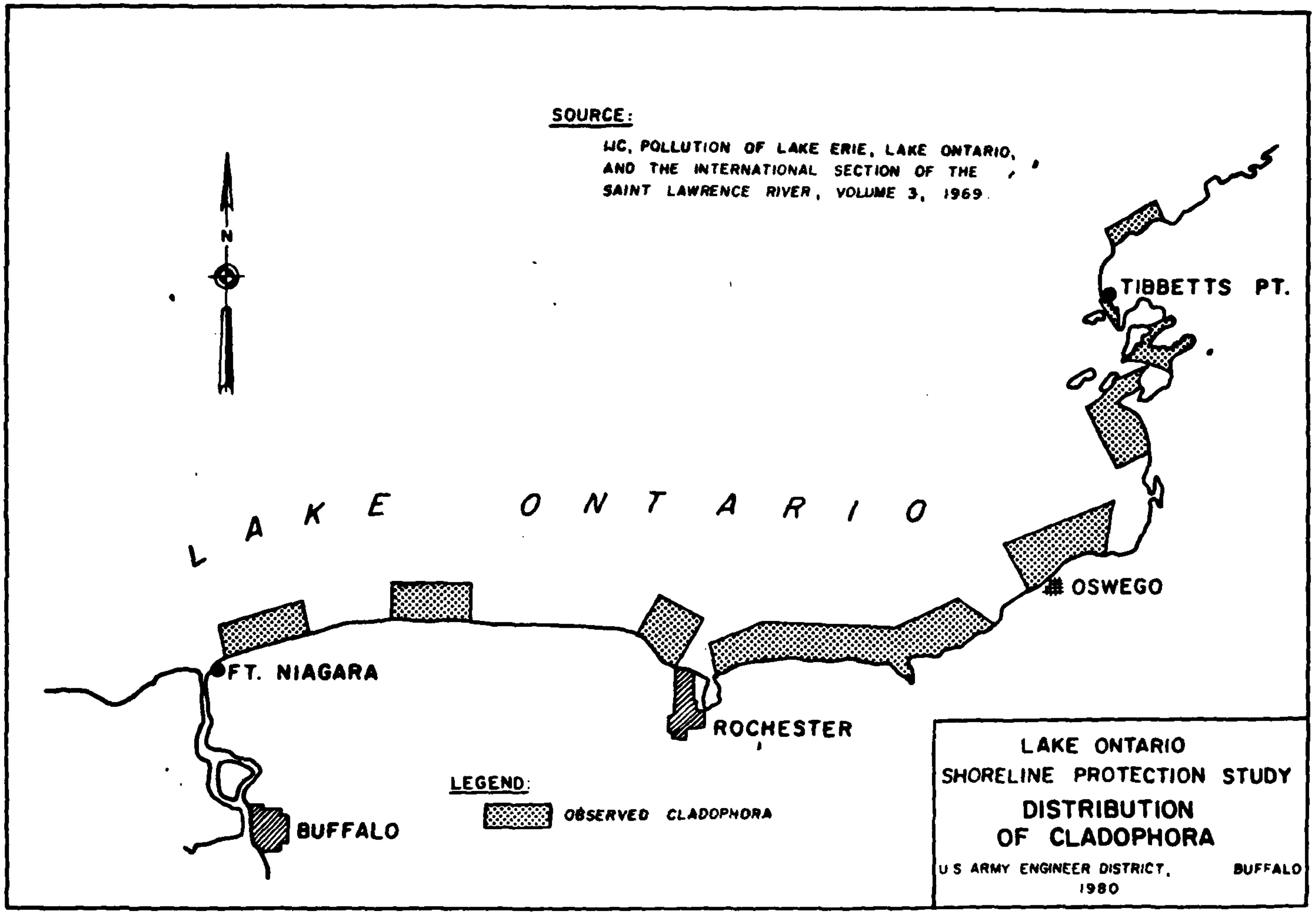

SOURCE:
IJC, POLLUTION OF LAKE ERIE, LAKE ONTARIO, AND THE INTERNATIONAL SECTION OF THE SAINT LAWRENCE RIVER, VOLUME 3, 1969
N
LAKE ONTARIO
TIBBETTS PT.
OSWEGO
ROCHESTER
FT. NIAGARA
BUFFALO
LEGEND:
OBSERVED CLADOPHORA
LAKE ONTARIO
SHORELINE PROTECTION STUDY
DISTRIBUTION OF CLADOPHORA
U S ARMY ENGINEER DISTRICT, BUFFALO
1980

Figure 2.15

degraded water quality, including many potentially nuisance causing species. In addition, high levels of phytoplankton standing crop have been reported throughout the lake at all times of the year, further indicating a severely eutrophied state ([Chau et al 1970; Nicholson, 1970; Glooschenko et al, 1973] Stoermer et al, 1975).

Lake Ontario is regarded as a disturbed system in which biological and seasonal trends differ considerably from those of the other Great Lakes (Stoermer, 1973). This condition effects the phytoplankton population both qualitatively and quantitatively. Information suggests that differences in abundance and composition are apparently related to variable weather conditions during the spring phytoplankton maximum (Stoerman, 1973). Thus, phytoplankton assemblages of Lake Ontario appear to be highly variable.

The general pattern of Lake Ontario's phytoplankton is that it undergoes seasonal succession, with diatoms predominating during the winter and early spring. During this time the diatoms comprise 80 percent of phytoplankton volume (Munawar and Nauwerck, 1970). Green algae become abundant during the summer months followed by the blue-green algae showing a distinct fall peak.

This cycle of succession also follows a general pattern of distribution and location within the lake. There are isolated spring blooms of organisms in the nearshore areas during March. Numbers of phytoplankton increase, thereby expanding populations to all nearshore areas by April. This development seems to start at the eastern and western ends of the lake, then spreading along the southern shore before becoming evident along the northern shore or mid-lake regions (Stoermer et al 1975).

Cacillariophyceae, or diatoms, are unicellular algae characterized by having a cell wall of silica. Dominant genera present in Lake Ontario are Stephanodiscus, Asterionella, Fragilaria, Diatoma, Melosira, Tabellaris and Nitzschia (Reinwand, 1964; Stoermer et al, 1975; Thomas, 1976).

The green algae, Chlorophyceae contain a vast number of morphologically diverse organisms. This class of algae dominates Lake Ontario during the summer months. Green algae usually shows two separate peaks during the summer months - one in June and another in August. Gloeocystis planctonica and Coccomyxa coccoides appear during June in minor quantities and increase during July replacing the dominant diatoms of spring (Stoermer, 1973). Other algae which become predominant are Ankistrodesmus, Sphaerocystis, Scenedesmus, and Coelstrum (Ogawa, 1964; Stoermer, 1973).

Division Cyanophyta (Myxophyceae), blue-green algae, is the third major category of algae present in Lake Ontario. This group almost invariably develops as filaments or as small colonies of various shapes and sizes (Cronquist, 1961). Species of this Division peak in late summer or fall and many times are associated with nuisance blooms. Major species associated with these blooms in Lake Ontario are Aphanizomenon flos-aquae, and Anacystis cyanea (Stormer, et al, 1975). Other blue-green genera, found throughout the lake are Gomphosphaeria, Anacystis, Aphanizomenon, Anabaena, Chroococeus and Oscillatoria (Munawar and Nauwerck, 1970, Stoermer, 1975).

There are two additional Divisions that have generally been found through Lake Ontario, Pyrophyta and Euglenophyta. Division Pyrophyta mostly unicellular flagellates, is represented by Dinophyceae or dinoflagellates. Representative genera include Ceratium and Peridinium. During a May 1972 phytoplankton investigation of the shoreline from Rochester to the western end of Lake Ontario, one species Peridinium aciculiferum, was found to be very abundant in a spring sampling where it comprised 27 percent of the biomass (Thomas, 1976).

The division Euglenophyta (the euglenoids), genus Trachelomonas, is not a major component of the phytoplankton, but is found throughout the whole lake (Ogawa 1964).

Another class, Cryptomonadineas of the phylum Sarcomastigophora is a small morphological group of flagellates that contains a few significant members of the plankton flora. Two species - Cryptomonas erosa and Rhadomonas minuta - seem to be continuously encountered throughout the lake whenever samples are taken (Thomas, 1976); (Stoermer et al 1975, Corps 1979).

With regard to other existing data on phytoplankton, detailed inventories of phytoplankton have been made for various specific locations along the lake. These inventories are often associated with projects of the Corps of Engineers. Niagara County has a comprehensive inventory for Somerset, NY. This data is species specific and comprehensive for the following divisions of algae: Cyanophyta, Chlorophyta, Chrysophyta, Euglenophyta, Pyrrhophyta, Cryptophyta (Corps 1979). Monroe County has a detailed inventory for Irondequoit Bay and the adjacent lakeshore. Represented divisions are Chlorophyta, Cyanophyta, Chrysophyta, Euglenophyta, and Pyrrophyta. (Ellis et al, 1977). Wayne County has data taken from Great Sodus Bay which is brief in nature. Survey results showed heavy blooms of the diatom Asterionella and blooms of a green algae, Spirogyra in the spring. A blue-green algae, Anabaena spiroides was found to be plentiful in the fall. A dinoflagellate, Ceratium, and a green algae, Closterium, were found througout the bay during the 12-month study period (Corps, 1975).

Cayuga County has various sites where phytoplankton inventories have been compiled. Little Sodus Bay has data for the period February - April 1975. During this study period diatoms were most abundant. The genera Navicula, Asterionella, Fragilaria, and Tubellaria were well represented. One green algae was reported in the bay - Chlamydomnas (Corps, 1975) in Cayuga County. A second site inventory located at the proposed Sterling Power Plant, 8 miles southwest of Oswego, reported diatoms of the genus Asterionella and green algae of the genera Spyrogyra and Nicrospora as dominant from April through June. In July through September, blue-green algae - especially Oscillatoria and the green algae Pandorina, Staurastum, and Pediastrum - were found to be most abundant (Rochester Gas and Electric, 1976).

Additional surveys conducted include environmental studies of Nine Mile Point and Fitzpatrick Power Plants, both located on Lake Ontario approximately 7.5 miles east of Oswego. These studies revealed the diatom Stephanodiscus tenius as being prevalent throughout this vicinity (Corps

1975); Niagara Mohawk 1973). Other diatoms present were Melosira, Asterionella and Nitzschia (Niagara Mohawk, 1973). These same genera are felt to be representative of those found in Oswego Harbor (Corps, 1975).

A literature search for site specific phytoplankton information relative to Orleans, Jefferson and St. Lawrence County shoreline revealed no apparent information is available for these areas.

2.14.3 ZOOPLANKTON

The major structure of zooplankton in Lake Ontario is comprised of free-living nonphotosynthetic Protista, Crustacea, and Rotifera organisms. These three groups form the greater proportion of both species and individuals in the lake. Other components of zooplankton - but in smaller proportions - are coelenterates, flatworms, gastrotrichs, mites, and larval insects (Hutchinson, 1967).

Investigations performed in Lake Ontario in 1972 from May through July, indicated that the species Cyclops bicuspidatus and Bosmina longirostris were dominant. These species seem to have been dominant since 1969, not only on a seasonal basis, but yearly as well (International Lake Erie Water Pollution Board ... 1969). Bosmina is characteristic of lakes that are passing from an oligatrophic to eutrophic condition.

Additional crustacean studies of the nearshore zone from the vicinity of Rochester, NY, westward to the Canadian border, showed seasonal abundances of Cladocerans, cyclopoid copepods, calanoid copepods and copepod nauplii. Results of the studies indicated that cyclopoid copepods and copepid nauplii comprised 92 percent of the total of these groups (Thomas 1976). Copepod nauplii were found to be the most abundant group of zooplankton comprising the greatest biomass.

Cayuga County has a small amount of shoreline, however, two inventories on this aquatic zone have been performed. The areas are Little Sodus Bay and the Sterling Power Plant Site (8 miles southwest of Oswego). Data showed that zooplankton exhibited seasonal vertical distributions and that rotifers were the most abundant forms of zooplankton present. Copepods, Cladocerans and Ostracoes were also present in large quantities.

Individual rotifer genera were represented by Keratella, Polyarthra, and Asplanchra. Bosmina longirostris and Daphina spp. dominated the Cladocerans and Cyclops bicuspidatus was the most numerous species of copepod present (Corps 1975); Rochester Gas and Electric 1976).

Oswego County has inventories for the Oswego River and harbor area. The zooplankton population consisted almost entirely of rotifers, with Synchaeta, Polyarthra and Keratella being representative genera (Jackson, 1964). Additional studies have shown that 11 species of copepods and cladocerans have been reported. The most abundant genera were Cyclops, Trocyclops, Daphina, Bosmina, and Ceriodaphnia (Corps, 1975).

A literature review of Orleans, Jefferson and St. Lawrence Counties revealed that these areas have no researched site specific data on zooplankton that is available in published form.

Bosminids (a group of Cladocera) comprised the second most abundant zooplankton in the lake - with peak populations occurring in September. This cladoceran group dominated the sampling at a distance of about 1/2 kilometer from shore.

The third most abundant group were the immature cyclopoid copepods, which seemed to experience three population peaks - a June peak, early September peak, and an October peak.

Daphina retrocurva, detected in July, was the fourth most common species present. It was found to dominate inshore regions. Other genera present, in decreasing order, were Eubosmina and Draptomus (Thomas 1976).

Another large class of zooplankton organisms present were the rotifers. During Markello's studies (1973) of rotifer in the eastern Lake Ontario region, observations showed that 35 species of planktonic rotifers were noted. Species unique to the inshore area were Brachionus quadridentatus, Brachionus urceolaris, Polyathra euryptera, Polyathra dissimilans and Polyathra longiremis.

A detailed zooplankton inventory has been performed for the area of Somerset, NY. This inventory contains 149 zooplankton taxa. The dominant species identified were of the Class Crustacea and Rotifera, which included Polyarthra vulgaris (a rotifer), Codonella cratera (a protozoan), Bosmina logirostris and Cyclops bicuspidatus, both crustaceans (Corps, 1979).

Information for Monroe County was obtained for the area of Irondequoit Bay. Rotifers were found to comprise 50 percent of the total samples taken both in the bay and in Lake Ontario during May - the dominant genus was Keratella. This condition was still prevalent in July except in the bay. Cladocerans increased to 57 percent of the total biomass with Bosima coregoni being dominant. No equal distribution of zooplankton in the lake was detected in September. Rotifers, copepods and cladocerans each made up approximately a third of the total biomass. The bay did not have such an equal distribution of organisms. Rotifers decrease to 8 percent of the total, with Daphina and Chydories becoming prevalent - Cladocerans, Diaptomus and Cyclops being the dominate copepods. All species found in Irondequoit Bay were found in Lake Ontario. (Ellis, 1977).

Wayne County has only a brief inventory, and it is for Great Sodus Bay. Results showed that Ostracods (seed shrimp) cyclopoid copepods, harpacticoid copepods and amphipods (Gammarus sp.) made up the majority of zooplankton (State University College Oswego 1974 and Rochester Gas and Electric 1972).

2.15 WILDLIFE RESOURCES

The array of terrestrial and aquatic environments associated with the coastal zone provide habitat to support a diverse population of mammals,

birds, amphibians, and reptiles. References such as Robbins et al. 1966, Booth 1971; U. S. Fish and Wildlife Service 1976 and Webb et al. 1972, indicate that a variety of wildlife species have ranges which include the study area. A general overview of types of wildlife that have ranges which include the vicinity of Lake Ontario and/or the St. Lawrence River study area are provided below.

2.15.1 MAMMALS

In general, mammalian wildlife that have terrestrial ranges which may include the Lake Ontario Coastal Zone are one marsupial, two species of moles, five to seven species of shrews, six species of bats, 17 species of rodents, 13 species of carnivores, one specie of deer, and three lagomorphs (hares and rabbits).

2.15.2 BIRDS

General range maps for bird species given in a reference source entitled Birds of North America (Robbins et al. 1966), show that about 257 species have ranges that include part of, or all of the Lake Ontario-St. Lawrence study locale. Approximate number of species within each bird category is provided in parenthesis as follows: loons (2), grebes (3), cormorant (1), waterfowl (27), vulture (1), raptors (15), gallinaceous birds (5), egret (1), herons (3), bitterns (2), rails (5), coot (1), plovers (3), sandpipers (19), woodcock (1), snipe (1), gulls (4), terns (4), doves (2), cuckoos (2), owls (10), goatsucker (1), swift (1), hummingbird (1), kingfisher (1), woodpeckers (9) and perching birds (132).

2.15.3 AMPHIBIANS AND REPTILES

Conant's Field Guide to Reptiles and Amphibians of Eastern and Central North America (1975) provides an indication of the reptiles and amphibians that inhabit the vicinity of the study area. Using this reference as a general guide, it is estimated that 19 reptile species (turtles and snakes) and 19 amphibian species (newts, salamanders, toads, and frogs) inhabit areas relatively near or along the shoreline.

2.16 THREATENED AND ENDANGERED SPECIES

Pursuant to the Endangered Species Act of 1973 (16 U.S.C. 1531-1543: 87 Stat. 884), the U. S. Fish and Wildlife Service republished a "List of Endangered and Threatened Wildlife and Plants" in the Federal Register issue dated 17 Janaury 1979. This list represents the latest information available. Additionally, the New York State Department of Environmental Conservation published a list of native plants which shall be protected pursuant to Section 9-1503 of the Environmental Conservation Law, and a list of endangered species and wildlife. These aforementioned lists were used as general guidance in the identification of plant and animal species that must be considered in the overall planning effort.

The Lake Ontario-St. Lawrence River system, including its islands have well over 500 miles of shoreline (NCD, 1971). This area, extending from the

Niagara River at Youngstown, NY, to Massena, NY, contains at least 20 unique vegetational areas (Geis, 1972) and provides habitat for a variety of plant, amphibian, mammal, bird, and fish species. It is unlikely that all of the coastal zone area has been surveyed to identify locations of protected species, however, as new information becomes available, such data would be incorporated into future reports.

2.16.1 VEGETATION

a. Plant Species in NYS on the Federal Protected List. Only one plant species is listed as being "threatened" - northern wild monkshead (Aconitum noveboracense). According to Grays Manual of Botany (Fernald 1970) this plant is found in rich woods, shaded ravines and damp slopes in southeastern New York; the Manual of Vascular Plants (Gleason and Cronquist 1963) also indicates rich woods habitat for this plant and that with regard to New York State, it may be found in the Catskill Mountains.

b. Plant Species on the New York State Protected List. Over 34 genera of protected plants are contained on the New York State list. Among these plants are all species of orchids, clubmosses and ferns - except bracken fern (Pteridium aquilinum), hay-scented fern (Dennstaedtia punctilobula) and sensitive fern (Onoclea sensibilis).

Even though New York State has incorporated protected plant species into a concise list, coordination with the State Museum and review of State Coastal Zone management reports have not indicated specific locations of rare or endangered plant species along the shoreline. However, general locations of some unique vegetation sites were contained in some of the literature reviewed. Such sites are shown on county maps entitled "Coastal Zone Areas of Significant Environmental Concern" which are included in this reconnaissance report. Additionally, various other reports and studies by some organizations and individuals provide a clue to possible locations of New York State protected species, others identify actual sightings of protected species, while others identify critical habitats that could support and nurture various plants on the protected list. Information in this regard for counties bordering the Lake Ontario-St. Lawrence River shoreline follows:

c. Niagara and New Orleans Counties. In the lake towns of Porter, Wilson, and Newfane there have been sightings of pipissewa (Chimaphila umbellata), fringed gentian (Gentiana crinata), canada lily (Lilium canadense), wood lily (Lilium philadelphicum) and golden seal (Hydrastis canadensis) (Zander 1976). Although at present, these species have been sighted in the aforementioned counties, special caution should be exercised in the general locale of Boat Creek, Twelve Mile Creek, Wilson-Tuscarora State Park, Hopkins Creek, Krull Park near Olcott, Oak Orchard Swamp and Sphagnum Bog at Barre Center, since these areas have had a reputation for importance as botanical refuges for native wild flowers, ferns, trees, and shrubs (Zander, 1976).

d. Monroe County. The county has approximately 40 miles of shoreline and is rich in wetlands, woodlands, and sandy shore habitats. Although no documented sightings of protected plants were found for areas along the

coastal zone in literature that was reviewed, the shoreline area appears to contain a diversity in habitat that would need to be further investigated - particularly if structural water resource planning measures are considered for this area.

e. Wayne County. There are a number of unique topographic features located along the county shoreline (i.e., Sodus Bay, Port Bay, East Bay, tributary streams and peripheral terrestrial areas along the coast) offering a diversity of habitat for growth of a variety of plant species. Within Wayne County, only one documented sighting of a terrestrial NYS protected plant species was recorded in the literature reviewed - rosebay (Rhododendron maximum). There is also a nondocumented sighting of orange-milkweed (Asclepias tuberosa) (Corps 1975) in this area. It is probable that other protected plants may be present, but onsite field evaluation would be necessary to make a more complete determination.

f. Cayuga County. The lakefront shoreline for Cayuga County is short in length, compared to other coastal counties along the Lake Ontario-St. Lawrence River System. However, this county has a number of NYS protected plant sightings. A shrub called rosebay (Rhododendron maximum) was sighted in fields near little Sodus Bay (Corps 1975). The general locale around Somerset in the vicinity of the proposed Cayuga River Power Station contains documented sightings of the following protected plants (Corps 1979): lady fern (Athyrium filix-femina), grape fern (Botrychium virginianum), rattlesnake fern (Botrychium dissectum), bittersweet (Celastrus scandens), flowering dogwood (Cornus florida), shield fern (Dryopteris austriaca), male fern (Dryopteria filis-mas), helleborine (Epipactis helleborine), fringed gentian (Gentiana crinata, cardinal flower (Labelia cardinalis), cinnamon fern (Osmunda cinnamomea), Christmas fern (Polystichium acrostichoides), rose pink (Sabatia angularis), New York fern (Thelypteris noveboracensis), marsh fern (Thelypteris palustris), ostrich fern (Matteuccia strutheopteris), winterberry (Ilex montana), purple trillium (Trillium erectum), large-flowered trillium (Trillium grandiflorum), trillium (Trillium spp.). In view of the variety of protected plant species sighted, there is potential that specific locations of such plants may exist near the lakeshore and tributary streams, however this would have to be determined by further field investigation.

g. Oswego County. Oswego County has a unique dune/bay/wetland complex that is exceptionally rich in natural resources (NYS 1979) which extends into Jefferson County, NY. Within this complex, the interspersion and juxtaposition of marshes, open water, islands, littoral zone, barrier dunes, beaches and upland forests offers a unique ecological habitat. Its marshes, open water, islands, littoral zone, barrier dunes, beaches and upland forests offer habitat for a variety of plant species. This locale contains a number of bogs which offer possible habitat for growth of the pink orchid (Arethusa bulbosa); although this plant is not documented as yet, the critical habitat exists for it in this area (St. Lawrence-Eastern Ontario Commission 1978).

Investigations of Oswego County's coastal zone performed in 1976 by Rice Creek Biological Field Station investigators, confirmed the existence of various protected plants. No specific locations were indicated in the habitat and wildlife inventory report, but the following significant plants were

found near the shoreline: running clubmoss (Lycopodium clavatum), ground pine (Lycopodium obscurum), ground cedar (Lycopodium trystachyum), showy ladyslipper (Cyprepedium reginae), weed orchid (Epipactis helleborine (weed orchid), green woodland orchid (Habenaria clavellata), white adders mouth (Malaxis monophylla) and nodding ladies tresses (Spiranthes cernua) (Bieber et al., 1976). The county has a number of old fields near the shoreline, some of which have been found to contain cardinal-flower (Lobelia cardinalis) and running or trailing evergreen (Lycopodium complanatum) (St. Lawrence-Eastern Ontario Commission 1978).

h. Jefferson and St. Lawrence Counties. Both Jefferson and St. Lawrence Counties contain long and diverse coastal areas that offer potential habitat for growth of unique vegetation. Literature reviewed did not specify documented location sightings of NYS protected plant species in this locale, however, a study by Geis and Luscomb on the St. Lawrence-Eastern Ontario Shoreline (1972) notes that a number of unique vegetational areas exist along the coastal zone. Such significant areas are found in the vicinity of dunes, bays, wetlands and tributaries, as well as along the diverse terrestrial topography of the coastal zone.

2.16.2 MAMMALS

a. Mammal Species in NYS on the Federal Protected List. The following two species are listed as endangered: 1) eastern cougar (Felis concolor cougar) which had a range that included wilderness mountains, swamps, and forests of northeastern USA. Last known records of the cougar in New York State dates back around 1894 (NYSDEC 1970); 2) Indiana bat (Myotis sodalis) which has a range that includes eastern USA. This bat is declining in numbers due to the destruction of its limestone caves habitat by commercialization. There is a location in the study area where critical habitat exists for the Indiana bat - limestone caves along the Black River in Jefferson County. There has been a relatively recent documented sighting of this bat made near the aforementioned caves (Bieber et al. 1976).

b. Mammal Species on the New York State Protected List. The above two mammal species, plus the eastern timber wolf (Canis lupus lycaon) are included on the NYS list. The eastern timber wolf's range includes wilderness.

2.16.3 REPTILES

a. Reptile Species in NYS on the Federal Protected List. To date, the only reptile listed is the bog turtle (Clemmys muhlenbergi). This turtle occupies sphagnum bogs, swamps, and wet meadows having shallow waters open to sunlight. Populations of the bog turtle have declined due to overharvesting by pet dealers and destruction of its habitat by filling and drainage of wetlands. This turtle was thought to be rare in Wayne County around 1920 (Wright 1919 in Bieber et al. 1976). No recent documented sightings along the coastal zone were found in literature reviewed and its status along the lake is unknown. If this turtle is present in the study area, it is probably extremely rare and located in small restricted habitats (Forbes 1970 in

Bieber et al. 1976). The areas of Deer Creek and the South Pond Marshes probably provide "the best possibly for its presence" (Bieber et al. 176).

2.16.4 SNAILS

a. Snail Species in NYS on the Federal Protected List. A single species, Chittenango ovate amber snail (Succinea chittenangoensis) is listed as threatened in New York State.

b. Snail Species on the New York State Protected List. The abovementioned snail (Succinea ovalis chittenangoensis) is an endangered species on the NYS list. It is found in one area in New York State - Madison County (McCaffrey 1978).

2.16.5 INSECTS

a. Inspect Species in NYS on the Federal Protected List. None.

b. Insect Species on the New York State Protected List. There are no State protected insects likely to be found in the study area. Although, the State classifies the Karner blue butterfly (Lycaeides melissa samuelis) as endangered, its food source, a plant known as blue lupine, is very isolated. This plant has only one known large concentration in the State - the sandy Pine Bush area located west of Albany - however, there are some smaller remote blue lupine populations established on scattered areas in Upstate New York (McCaffrey 1978).

2.16.6 FISH

a. Fish Species in NYS on the Federal Protected List. Three fish species are listed as endangered - longjaw cisco (Coregonus alpenae) distributed in Lakes Michigan, Huron and Erie; blue pike (Stizostedion vitreum glaucum) whose range distribution is lake Erie and Lake Ontario, and shortnose sturgeon (Acipenser brevirostrum) which probably never existed in the Lake Ontario-St. Lawrence River area. There were some reported sightings of this sturgeon, but these were most likely erroneous and a case of improper classification (Scott and Crossman, 1973). The 17 January 1979 issue of the Federal Register on endangered and threatened wildlife and plants indicates the known distribution of shortnose sturgeon to be along the Atlantic Coast of the United States and Canada.

b. Fish Species on the New York State Protected List. The aforementioned three fish species are also included on the State protected list.

In a recent issue of "Fisheries" (AFS, Feb.-Mar. 1979) the status of two other fish species are considered to have endangered status due to destruction of habitat, overutilization, hybridization and competition: shortnose cisco (Coregonus reighardi reighardi) and blackfin cisco (Coregonus nigripinnis).

2.16.7 BIRDS

a. Bird Species in NYS on the Federal Protected List. Four birds that occur or may occur in New York State are listed as endangered in the 17 Janaury 1979 Federal Register: the bald eagle (*Haliaeetus leucocephalus*), the American peregrine falcon (*Falco peregrinus anatum*), the American peregrine falcon (*Falco peregrinus anatum*) and the Arctic peregrine falcon (*Falco peregrinus tundrius*).

b. Bird Species on the New York State Protected List. The NYSDEC document entitled "Traffic in Endangered Species of Fish and Wildlife" specifies in Section 182.1(b) the bird, reptile, insect, and invertebrate species considered to be threatened with extinction. Bird species in this category are the northern bald eagle (*Haliaeetus leucocephalus alascanus*) and the American osprey (*Pondion haliaetus carolinensis*). Section 182.1(c) also names other bird species, considered to be endangered that have occurred or may be expected to occur in NYS, which includes the eskimo curlew (Numenius borealis), the southern bald eagle (*Haliaeetus leucocephalus leucocephalus*), the American peregrine falcon, and the Arctic peregrine falcon.

In New York State, the exact status of the bald eagle is not known, however, there have been a number of sightings of both adult and juvenile eagles in the Lake Ontario-St. Lawrence River region. Birds of New York State (Bull 1974) points out general locations where bald eagles were observed or nest sites were reported: Youngstown (Niagara County), Troutburg (Monroe County), Sodus Bay (Wayne County), Goose Bay, Point Peninsula, Galloo Island, Stony Island, near Snowshoe Bay, near Stony Point, south of Henderson Harbor Village in Jefferson and St. Lawrence Counties, Selkirk Shores and Butterfly Swamp in Oswego County. Available literature indicates that the bald eagle is more a yearly migrant through the State. The spring 1978 bird migration report for Braddock Bay (Monroe County) showed a total of 14 bald eagle sightings (Moon 78). The Derby Hill (Oswego County) bird migration report indicated ten eagle sightings - seven immatures and three adults (Onondaga Audubon Society 1978). The upper lake and St. Lawrence River provides wintering areas for eagles. Two eagles were reported seen on Sugar Island in the vicinity of six existing nests. There was a report that one of the eagles was seen sitting on one of the nests, but closer investigation revealed no debris around any of the nests, so it was assumed the bird was only perching (Robinson 1979). The pair was apparently observed near Sugar Island during the winter of 1979.

The New York State Conservation Department (NYSDEC) has been conducting eagle surveys in the St. Lawrence River area during winter months, to document sightings and to obtain information needed to determine status of this bird. In the winter of 1978-79, three immature eagles were seen and recorded by ground survey crews, and three adults were seen and recorded by aerial surveys. These birds were seen in the area of Oak Point, located approximately 10 miles north of Chippewa Bay. An additional immature eagle was seen in the Galop Island region just north of Ogdensburg. These areas contain open water year-round and are relatively secluded. Additional sightings made in 1977-78 recorded a total of seven birds (telephone communication with NYSDEC). Data found through such surveys indicate that the bald eagle is

present along the coastline at various times of the year. These sightings have been as recent as May 1979.

The American and Arctic peregrine falcons are occasional migrants along the Lake Ontario - St. Lawrence River coastline. Six peregrine falcons were observed during the spring 1978 Braddock Bay bird migration count (Moon 1978). Also peregrines were observed at various sites along the lake and at New Haven in Oswego County (NYS Electric and Gas 1979). Presently, there is no known nesting site for this species in the State. However, it should be noted that the area in the vicinity of Henderson Harbor and Galloo Island offers potential cliff habitats for use by this species.

Another bird species that could be expected to occur in the State is the eskimo curlew. This bird has been known to migrate south across New York State to Long Island from northern Mackenzie. It was thought to be extinct, but there were a few sightings in Texas in the 1960's (Bull 1974).

With regard to the American Osprey, this bird is known to breed in the State (St. Lawrence-Eastern Ontario Commission (1972)). Sightings of osprey were made in a survey done in the winter of 1978-79 throughout the St. Lawrence River area (Robinson 1979). Potential nesting areas for osprey are Barnett Marsh on Wellesley Island, Flynn and McCrae Bays and Delaney Marsh on Grindstone Island. These areas are suitable habitats for induced nesting (St. Lawrence-Eastern Ontario Commission (1972)).

HUMAN ENVIRONMENT

2.17 POPULATION

The population of the eight-county area bordering the Lake Ontario and St. Lawrence River shoreline (U. S.) was 1,443,000 in 1970, at that time this represented 22 percent of the Upstate 1/ New York population. Nearly half of the population lived in Monroe County alone. The population of the 43 Minor Civil Divisions (MCD) (40 townships and three cities) that comprise the Lake Ontario and St. Lawrence River shoreline was 650,000. Over 70 percent of that total lived in the six MCD's comprising the Monroe County shoreline. The highly urbanized city of Rochester in 1970 had over 296,000 inhabitants. Figure 2.16 illustrates population densities of counties and MCD's which comprise the shoreline. The area exhibiting the densest population on the shoreline is again in Monroe County in and around the city of Rochester having a population density exceeding 8,000 inhabitants per square mile. Other urbanized areas along the shoreline which experience relatively high population densities include the cities of Oswego and Ogdensburg, both exceeding 3,000 persons per square mile.

The population of the Lake Ontario and St. Lawrence River counties increased by 88 percent between 1910 and 1970, as compared to New York State

1/ Excludes New York City and Nassau, Putnam, Rockland, Suffolk, and Westchester Counties.

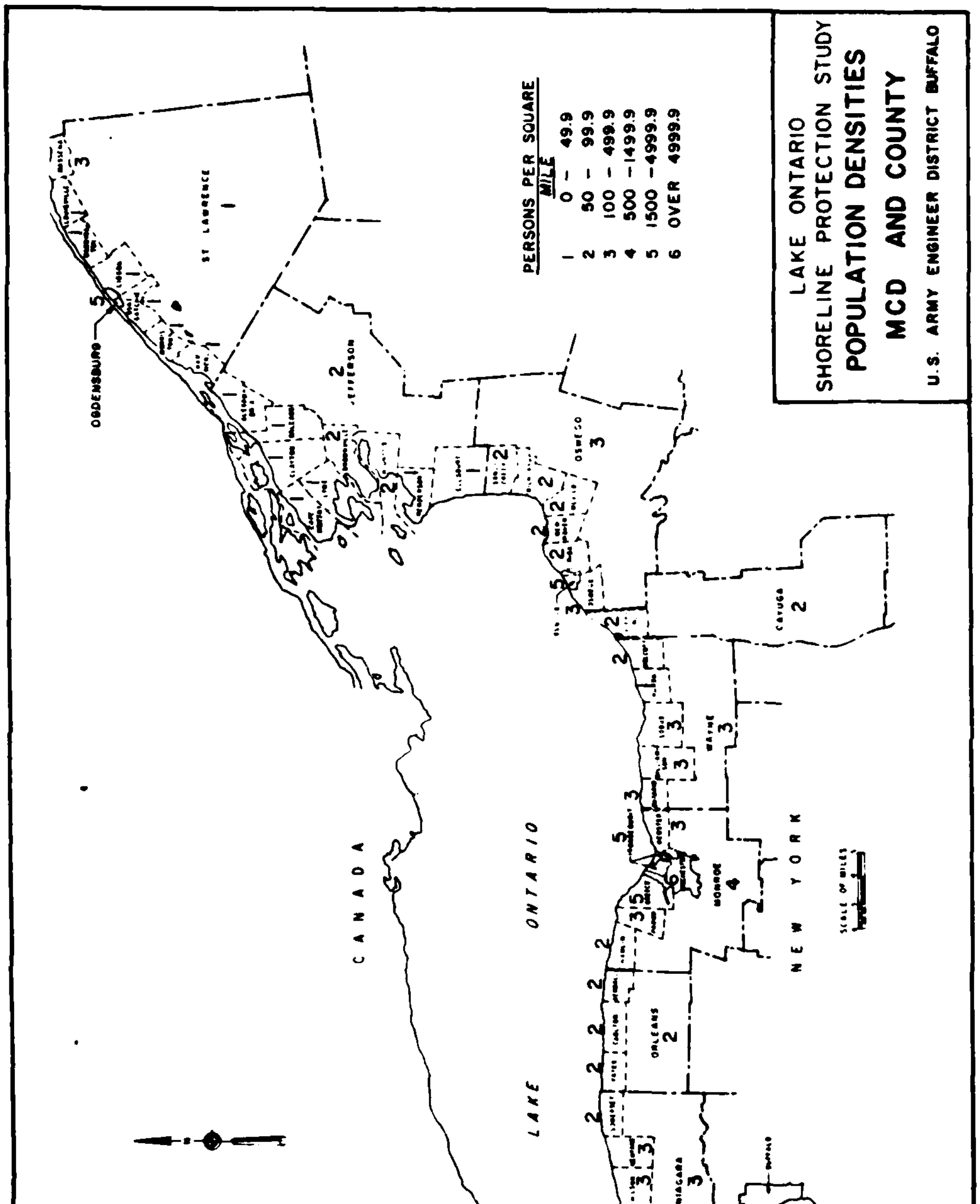

LAKE ONTARIO
SHORELINE PROTECTION STUDY
POPULATION DENSITIES
MCD AND COUNTY
U.S. ARMY ENGINEER DISTRICT BUFFALO
PERSONS PER SQUARE MILE
1 0 - 49.9
2 50 - 99.9
3 100 - 499.9
4 500 - 1499.9
5 1500 - 4999.9
6 OVER 4999.9
CANADA
LAKE ONTARIO
NEW YORK
LAKE ERIE
ST LAWRENCE
JEFFERSON
OSWEGO
CAYUGA
WAYNE
MONROE
ORLEANS
NIAGARA
OGDENSBURG

Figure 2.16

population which more than doubled for the same time span. Monroe County experienced a relatively high increase in population (151 percent), typical of urbanized areas during this century. The population for the city of Rochester has been steadily declining since 1950, resulting from the suburban sprawl phenomenon. During that span, the ring of towns encompassing Rochester grew rapidly as did the transportation network, thus enabling residents to commute to and from the central business district. Table 2.16 illustrates the decadal growth of population by shoreline counties (1910-1970), along with their average annual growth. The counties of Niagara and Monroe are the only shoreline counties with a population growth rate that exceeds that of Upstate New York.

2.18 INCOME

Tables 2.17 and 2.18 exhibit comparative income statistics for counties bordering Lake Ontario and the St. Lawrence River shoreline. Median income ranged from $8,667 in rural St. Lawrence County to $12,423 in highly urbanized Monroe County in 1969. Three of the eight shoreline counties, Monroe, Wayne, and Niagara, realized median incomes exceeding the median income for Upstate New York. Those counties associated with urban areas generally enjoy higher income levels than rural counties. Monroe and Wayne Counties are economically and socially related with the central city of Rochester and, therefore, are part of the Rochester Standard Metropolitan Statistical Area (SMSA). Niagara County is included in the Buffalo SMSA. The spatial distribution of median income by shoreline MCD's is shown in Figure 2.17. This illustration supports the hypothesis that generally higher income areas are related with urbanized areas and lower median income areas with rural areas. Though Monroe County exhibited the highest personal income per capita in 1974 ($6,628), it is evident from Table 2.18 that between the years 1972-1974, all of the eight study area counties experienced a substantial increase in per capita income. The shoreline counties comprising part of the Rochester SMSA, Orleans, Monroe, and Wayne, exhibited the greatest 3-year growth with increases ranging from $1,100-1,200.

2.19 HOUSING

The housing stock within the study area widely varies as do other factors comprising the socio-economic climate. Housing characteristics at the county level reflect housing of a general nature and are presented in Tables 2.19 and 2.20. In 1970, there were over 473,000 housing units in the eight-county area encompassing the shoreline study area. The Minor Civil Divisions along the shoreline contained over 226,000 housing units, 4.9 percent of them being seasonally vacant. Excluding the cities of Rochester, Oswego, and Ogdensburg, analysis revealed that the shoreline townships contained 10 percent seasonally vacant housing units, while total shoreline counties contained only 3.5 percent seasonally vacant housing units. "Seasonal" units are intended for occupancy during only certain seasons of the year. Included are units intended for recreation use, such as beach cottages and hunting cabins. This percentage difference can be explained by the recreational advantages of proximity to Lake Ontario.

Table 2.16 - Population (Thousands), Including Institutions, By Shoreline Counties

	1910	1920	1930	1940	1950	1960	1970	Average Annual Growth Rate 1910-1970	Average Annual Growth Rate 1960-1970
Niagara	92.0	118.7	149.3	160.1	190.0	242.3	235.7	1.58	-.28
Orleans	32.0	28.6	28.8	27.8	29.8	34.2	37.3	.26	.87
Monroe	283.2	352.0	423.9	438.2	487.6	586.4	711.9	1.55	1.96
Wayne	50.2	48.8	50.0	52.7	57.3	68.0	79.4	.77	1.56
Cayuga	67.1	65.2	64.8	65.5	70.1	73.9	77.4	.24	.46
Oswego	71.7	71.0	69.6	71.3	77.2	86.1	100.9	.57	1.60
Jefferson	80.4	82.7	83.6	84.0	85.5	87.8	88.5	.16	.08
St. Lawrence	89.0	88.1	91.0	91.1	98.9	111.2	112.0	.38	.07
Eight-County Area Total	765.6	855.1	961.0	990.7	1,096.4	1,289.9	1,443.1	1.06	1.13
Upstate New York	3,822.0	4,128.2	4,599.3	4,758.5	5,253.9	6,055.9	6,608.9	.92	.88

Source: New York State Statistical Yearbook, 1977 Ed.

Table 2.17 - Income of Families - 1969

County	Median Income	Number of Families	Income Groups - Percentage of Families							
			Under $3,000	$3,000-4,999	$5,000-6,999	$7,000-9,999	$10,000-14,999	$15,000-24,999	$25,000-49,999	$50,000 or Greater
Niagara	$10,203	59,542	6.6	6.9	9.9	25.0	32.4	16.2	2.5	0.5
Orleans	10,119	9,230	6.8	8.4	11.5	22.6	30.5	16.8	3.2	0.3
Monroe	12,423	175,934	5.2	5.8	7.2	15.4	32.4	27.1	6.1	0.9
Wayne	10,508	19,319	6.9	7.3	10.3	21.4	33.5	17.4	2.7	0.5
Cayuga	9,311	18,429	8.7	9.0	13.0	24.9	28.9	12.8	2.4	0.2
Oswego	9,254	24,057	9.4	8.8	12.6	25.2	28.4	13.5	1.9	0.1
Jefferson	8,696	21,707	9.3	11.3	15.1	24.7	26.5	10.8	1.7	0.4
St. Lawrence	8,667	24,765	9.7	10.6	14.7	25.6	25.6	11.0	2.5	0.3

Source: New York State Business Fact Book, Part 2, 1974 Ed.

Table 2.18 - Personal Income and Personal Income Per Capita, By County of Residence 1972-1974

County	Personal Income (Millions)			Personal Income per Capita		
	1972	1973	1974	1972	1973	1974
	$	$	$	$	$	$
Niagara	1,023.9	1,118.7	1,212.1	4,302	4,695	5,084
Orleans	158.8	183.7	205.0	4,185	4,787	5,358
Monroe	3,887.7	4,246.2	4,702.0	5,435	5,952	6,628
Wayne	348.3	396.5	442.2	4,371	4,950	5,573
Cayuga	307.1	331.1	361.5	3,966	4,303	4,709
Oswego	397.4	427.5	468.1	3,697	3,989	4,287
Jefferson	341.8	377.7	401.7	3,714	4,128	4,391
St. Lawrence	383.5	421.1	468.5	3,297	3,649	4,023
Eight-County Area Total	6,848.5	7,502.5	8,261.1	4,677	5,135	5,658

Source: New York State Statistical Yearbook, 1977

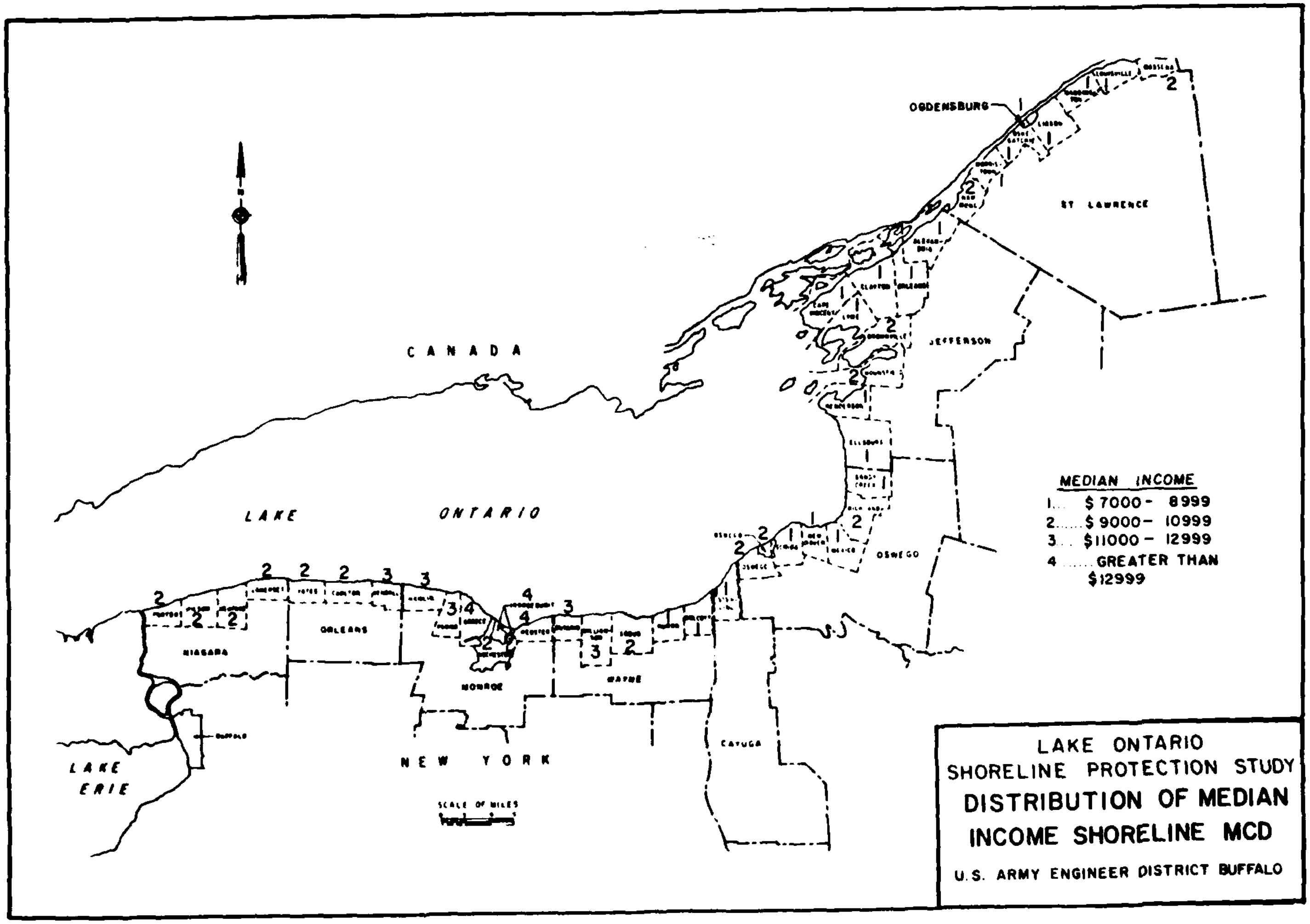

LAKE ONTARIO
SHORELINE PROTECTION STUDY
DISTRIBUTION OF MEDIAN
INCOME SHORELINE MCD
U.S. ARMY ENGINEER DISTRICT BUFFALO
MEDIAN INCOME
1.... $7000- 8999
2.... $9000- 10999
3.... $11000- 12999
4.... GREATER THAN
$12999
CANADA
LAKE ONTARIO
LAKE ERIE
NEW YORK
OGDENSBURG
ST LAWRENCE
JEFFERSON
OSWEGO
CAYUGA
WAYNE
MONROE
ORLEANS
NIAGARA
SCALE OF MILES

Figure 2.17

Table 2.19 - Housing Characteristics, 1970
Shoreline Counties

	Counties									
	Niagara	Orleans	Monroe	Wayne	Cayuga	Oswego	Jefferson	St. Lawrence	Upstate New York	Total Eight-County Area
Housing Units										
Total Number	74,695	12,901	228,554	26,314	26,348	32,857	34,698	36,738	2,253,654	473,305
Total Occupied	71,881	11,320	220,554	23,553	22,987	29,179	27,435	30,354	2,021,363	437,263
Percent Owner-Occupied	69.9	75.3	64.9	75.5	72.3	76.1	69.4	74.1	67.1	68.6
Total Seasonally Vacant	681	905	695	1,345	1,782	1,975	5,165	4,039	107,937	16,587
Year Structure Built (Percent All Year Units)										
1960-Mar. 1970	12.3	12.8	23.8	17.8	12.4	19.1	11.4	13.3	17.3	19.5
1940-1959	33.3	11.0	25.7	17.3	12.2	16.7	11.5	18.7	23.7	23.4
1939 or earlier	54.4	76.1	50.5	64.9	75.5	64.2	77.2	68.0	59.1	57.7
Year Round Housing Units Percent in Structures With										
One Housing Unit	67.2	77.2	63.0	74.9	67.5	70.7	65.4	75.8	62.4	66.5
Two Housing Unit	16.0	10.1	13.4	10.6	16.4	10.1	14.6	7.9	17.4	13.2
3-9 Housing Unit	11.9	6.0	14.4	6.3	8.9	7.5	10.6	6.9	11.9	11.8
10 or More Housing Unit	2.7	1.4	8.5	1.3	2.9	1.9	3.2	2.7	4.9	5.5
Percent in Mobile Homes	2.1	5.3	0.7	6.9	4.2	9.8	6.3	6.6	3.4	2.9
Household (Occupied Units) Percent by Year Moved In										
1965-Mar. 1970	40.4	39.8	49.0	40.2	37.8	41.4	41.5	40.5	43.7	44.7
1950-1964	39.2	34.0	35.0	36.7	34.4	33.4	35.0	33.6	35.8	35.5
1949 or earlier	20.4	26.2	16.0	23.0	27.8	25.1	23.5	25.9	20.5	19.7

Source: New York State Business Fact Book, Part 2, 1974 Ed.

Table 2.20 - Housing Values

	Counties									
	Niagara	Orleans	Monroe	Wayne	Cayuga	Oswego	Jefferson	St. Lawrence	Upstate New York	Total Eight-County Area
Median Value	$15,800	$12,600	$21,800	$15,400	$13,600	$12,600	$11,000	$10,900	$ 17,400	-
Owner-Occupied 1-Family Structures	33,765	6,580	90,178	13,319	11,218	15,699	12,452	17,049	846,453	$200,260
Percent Reporting Specified Value										
Under $15,000	44.8	62.3	19.6	48.3	57.7	61.9	70.7	70.3	38.1	40.1
$15,000 - $24,999	43.2	30.1	44.5	37.3	31.4	29.4	21.3	22.1	41.5	38.0
25,000 - 34,999	8.6	5.6	23.7	10.8	7.6	6.6	5.0	5.6	13.8	14.8
35,000 - 49,999	2.5	1.7	9.2	2.8	2.3	1.7	2.2	1.6	5.1	5.3
50,000 or more	0.8	0.8	3.0	0.8	0.9	0.5	0.9	0.4	1.6	1.8

Source: New York State Business Fact Book, Part 2, 1974 Ed.

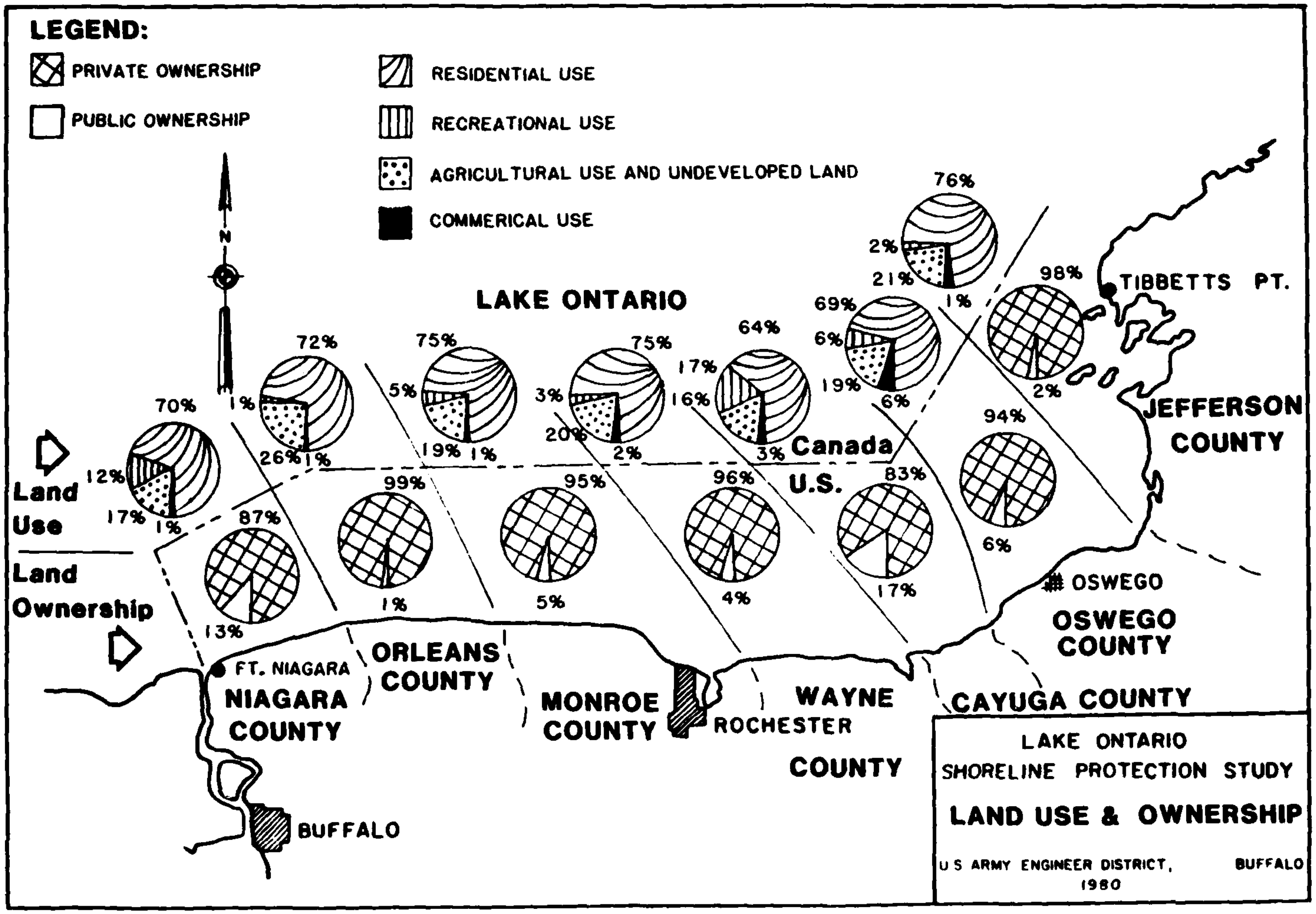
Monroe County displays housing characteristics which generally deviate from the remaining study area counties. Monroe County has the largest percentage of homes built in the decade 1960-1970, while the more rural counties contain homes built much earlier. This can be explained by the rapid growth in county population spurred by Rochester's fast-growing economy. Higher population density can explain why Monroe County has the least percentage (63 percent) of single housing units of the shoreline counties and the greatest percentage (8.5 percent) of multi-unit housing structures. The housing value structure among the study area counties varies from the high median value of $21,800 in Monroe County to the low median values of $10,900 and $11,000 for St. Lawrence and Jefferson Counties, respectively.

2.20 SHORELINE LAND USE AND DESCRIPTION

The variation in land use along the Lake Ontario shoreline typifies a diversity of population distribution, agricultural viability, recreational potential, industrial development, and other historical characteristics that have shaped the Lake Ontario shoreline into its existing land use. The land use and ownership data for Niagara, Orleans, Monroe, Wayne, Cayuga, Oswego, and Jefferson Counties were obtained from county tax records. The percentage of shoreline in each land use category was derived by noting the number of parcels within each category since the linear dimensions of many parcels were missing in the tax records. As shown on Figure 2.18, the land use categories are grouped into four classes: recreational, residential, agricultural and undeveloped, and commercial. Land ownership is described as public or private.

Residential land use accounts for 70 to 76 percent of the parcels in five out of seven counties. The percentages of residential lots in Cayuga and Oswego Counties are 64 percent and 69 percent, respectively. The percentage of commercial land exceeds 1 percent only in Wayne, Cayuga, and Oswego Counties where the percentages are 2 percent, 3 percent, and 6 percent, respectively. Agricultural and undeveloped land is less than 20 percent in Niagara, Monroe, Cayuga, and Oswego Counties. Agricultural and undeveloped land use accounts for 26 percent, 20 percent, and 21 percent of the land in Orleans, Wayne, and Jefferson Counties, respectively. Recreational land use is extensive in Cayuga and Niagara Counties, 17 percent and 12 percent, respectively. Orleans, Monroe, Wayne, Oswego, and Jefferson Counties have recreational land use ranging from 1 percent to 6 percent. Figure 2.18 also portrays the percentage of public and private land ownership for each shoreline county. Residentially developed land represents the major land use category of the shore zone, equaling 72 percent of the total. Agricultural and undeveloped lands amount to 20 percent. The remaining shoreline is divided between recreational, 6 percent; and commercial, 2 percent. Shoreline ownership is largely private, accounting for 93 percent of total land use. The remaining 7 percent is publicly owned lands.

Shoreline land use characteristics were also analyzed along Lake Ontario and the St. Lawrence River (U. S.) for various land areas. The land areas analyzed were 1,000-foot shoreline strips, shoreline minor civil divisions, and shoreline counties. The first of these utilizes the results of the Great Lakes Basin Commission's report on land use information for the Great Lakes



LEGEND:
PRIVATE OWNERSHIP
PUBLIC OWNERSHIP
RESIDENTIAL USE
RECREATIONAL USE
AGRICULTURAL USE AND UNDEVELOPED LAND
COMMERICAL USE
N
LAKE ONTARIO
Land Use
Land Ownership
70%
12%
17%
1%
72%
1%
26%
1%
75%
5%
19%
1%
75%
3%
20%
2%
64%
17%
16%
3%
69%
6%
19%
6%
76%
2%
21%
1%
87%
13%
99%
1%
95%
5%
96%
4%
83%
17%
94%
6%
98%
2%
Canada
U.S.
TIBBETTS PT.
JEFFERSON COUNTY
OSWEGO
OSWEGO COUNTY
CAYUGA COUNTY
WAYNE COUNTY
ROCHESTER
MONROE COUNTY
ORLEANS COUNTY
FT. NIAGARA
NIAGARA COUNTY
BUFFALO
LAKE ONTARIO
SHORELINE PROTECTION STUDY
LAND USE & OWNERSHIP
U S ARMY ENGINEER DISTRICT, BUFFALO
1980

Figure 2.18

coastal counties. The Commission conducted a detailed land analysis of a 1,000-foot wide coastal strip along Lake Ontario and the St. Lawrence River. Nine land cover classes were extracted using LANDSTAT satellite imagery. A LANDSTAT satellite imagery could not measure low density residential areas. A series of residential classes were obtained using data available from other sources. Table 2.21 contains the land cover for an approximate 1,000-foot wide strip of shoreline by county.

St. Lawrence-Eastern Ontario Commission (SLEOC) data indicates that St. Lawrence county shoreline properties account for 11.9 percent of the total county. These are predominantly used for seasonal residences 46 percent. Permanent residences, vacant, and other uses account for 12, 4, and 38 percent, respectively. St. Lawrence County land use publications indicate that shoreline development is scattered along the St. Lawrence River. The greatest concentration occurs between Morristown and Ogdensburg. Other concentrations occur along the shoreline centered at Oak Point, Waddington, and Massena. Table 2.22 presents the number of St. Lawrence County shoreline properties and their uses along with percentages of the total.

The larger commercial developments are centered at Rochester and Irondequoit, but there also are commercial developments at Henderson Harbor and Sackets Harbor. Several parks and recreation areas, including 15 State parks, are scattered along the New York shorelands. There are also numerous county and local parks and recreation areas located along the shore. Except for the cities of Rochester, Irondequoit, and Oswego, the developed areas consist of a few small communities and scattered strips of residential development adjacent to the shore. Behind the residential strip, the land is generally undeveloped or used for agriculture. Fruit crops predominate in the agricultural lands between Irondequoit and Oswego.

Serving the recreational boating demand are approximately 24 harbors or marinas spaced fairly evenly along the shoreline, and several launching ramps located on rivers leading to the lake. Many of the marinas are located at State and local parks. Rochester, Oswego, and Great Sodus have Federally maintained deep-draft harbors for commercial navigation.

2.21 EMPLOYMENT AND ECONOMIC ACTIVITY

Comparative employment statistics are presented in Table 2.23 for the eight shoreline counties that comprise the study area. In general, the figures presented typify an expanding diversified economy. Table 2.24 illustrates each county's employment distribution by industry.

Niagara County, the most western county of the study area, together with Erie County, comprise the Buffalo Metropolitan Area. Niagara Falls is the principal city in the county and attracts tourists from all over the world. The local economy is heavily dependent on the tourism trade. Niagara County typifies a highly diversified mix of industrial, commercial, and agricultural activities. Industrially, the county is supported by three important centers: Niagara Falls, Lockport, and North Tonawanda. In Niagara Falls there are two hydroelectric plants: the Robert Moses Niagara Power Plant and

Table 2.21 - Lake Ontario Land Cover for an Approximately 1,000-Foot Wide Strip of Shoreline by County*

County (Lake Ontario & St. Lawrence)	Total Area Ha	Percent									
		Inland Water	Wetland	Forest	Brushland	Grassland	Barren	Plowed	Total Urban & Residential	High Density Residential	Low Density Residential	Commercial
Cayuga	1.53	7	7	43	8	4	0	10	20	16	4	0
Jefferson	33.30	3	2	18	22	11	0	5	40	3	37	0
Monroe	7.06	4	3	20	5	1	0	2	65	16	48	1
Niagara	12.71	3	1	25	9	5	0	7	50	8	40	2
Orleans	4.71	0	1	19	8	4	0	8	60	3	57	0
Oswego	6.59	5	7	34	2	2	1	4	45	8	37	0
St. Lawrence	17.89	4	2	32	16	11	0	5	30	2	28	0
Wayne	7.18	3	8	30	7	6	0	6	40	11	29	0
Total	90.97	3.3	2.8	24.4	14.0	7.8	0.1	5.2	42.4	5.7	36.3	0.4

*This analysis was performed using computer retrievals, LANDSAT photo interpretation, as well as State and Federal land use documents. It represents a best estimate and must not be taken as 100 percent accurate.

Source: Summary of Existing and Projected Land Use Information for the Great Lakes Coastal Counties, Great Lakes Basin Commission.

Table 2.22 - St. Lawrence County Shoreline Development

	Number of Properties	Percent
Permanent Residential	229	12
Seasonal Residential	881	46
Vacant	81	4
Other	725	38
Total	1,916	100

Source: SLEOC, Report on Coastal Resources

Table 2.23 - Employment, Payrolls, and Average Weekly Earnings

County	Average Employment			Payrolls (Millions)			Average Weekly Earnings		
	1965	1970	1975	1965	1970	1975	1965	1970	1975
Niagara	60,583	63,326	63,266	393	510	670	103.97	134.19	169.89
Orleans	4,428	4,711	5,614	21	30	45	91.71	122.90	154.88
Monroe	213,479	243,276	267,730	1,420	2,119	3,192	127.95	167.53	229.25
Wayne	13,370	13,892	15,941	64	89	135	92.14	123.08	163.24
Cayuga	13,792	13,992	15,214	73	89	125	101.58	121.99	158.54
Oswego	14,232	15,091	16,004	76	106	145	102.25	134.67	174.82
Jefferson	16,576	18,487	20,220	83	121	173	96.67	125.53	164.98
St. Lawrence	17,625	19,019	20,952	102	138	205	111.52	139.64	188.09

Table 2.24 - Employment - Percentage Distribution by Industry, 1970

	Niagara	Orleans	Monroe	Wayne	Cayuga	Oswego	Jefferson	St. Lawrence	Eight County Total
Number Employed	87,610	13,945	291,906	29,249	28,357	33,919	31,753	55,790	552,529
Industry	%	%	%	%	%	%	%	%	%
Manufacturing	42.8	39.9	40.0	39.1	33.2	33.3	23.4	20.4	37.4
Service Industries	21.9	20.8	24.3	22.7	24.3	25.0	26.5	34.9	24.6
Retail Trade	15.5	13.3	15.0	13.2	14.9	14.8	17.4	15.2	15.1
Public Utilities	4.9	4.7	4.3	4.3	5.8	6.5	6.3	5.1	4.8
Contract Construction	4.3	5.1	4.8	5.9	5.6	8.2	6.1	5.9	5.2
Public Administration	3.8	3.8	3.3	2.7	5.8	3.6	6.5	3.8	3.7
Wholesale Trade	2.6	2.8	3.4	3.1	2.0	2.9	2.5	1.9	3.0
Finance, Insurance, Real Estate	2.6	2.1	4.0	1.9	2.8	2.7	4.3	2.5	3.4
Agriculture	1.7	7.4	0.7	7.0	5.4	3.0	6.6	7.3	2.5
Mining	0.2	0.3	1/	0.2	0.2	0.1	0.3	3.0	0.3

1/ Mining in Monroe County accounts for less than .05 percent of its total industries.

Source: Basic Statistics for Counties and Metropolitan Areas of New York State, 1973

the Lewiston pump-generating plant. Their installed capacities are 1,950 megawatts and 240 megawatts, respectively. Both plants are owned and operated by the Power Authority of the State of New York. Together, they supply power to the northeast power grid, consisting primarily of the northeastern United States and southern Ontario. Niagara Falls is also the center of the nation's electro-metallurgical industry and an important producer of chemicals and abrasives. The city of Lockport has a diversified industry, including the manufacture of automobile radiators and air conditioners. Located on the southern portion of the county, North Tonawanda's chief industry consists of heavy and light metal manufacturing.

Orleans County, bordering Niagara County on the west and Monroe County on the east, is part of the Rochester Metropolitan Area. The chief manufacturing industry of Orleans County is food processing. Other important manufacturing activities include toys and primary metals. The county's principal industrial centers are located in the county's most populated villages of Albion and Medina. It is important to note that commercial and industrial activities are not as extensive in Orleans County as they are in the more populated counties of Niagara and Monroe.

Monroe County, as stated previously, is the largest and most populous county of the Rochester Metropolitan Area. The business center for the county is located in the city of Rochester which is noted for its skilled trades and quality merchandise. Rochester's leading industrial products include photographic and photocopying equipment, optical goods, scientific instruments, men's apparel, dental equipment, machine tools, electric motors, auto parts, and communications equipment.

Wayne County borders Monroe County on its western border. Having social and economic ties with Rochester, Wayne County is part of the Rochester Metropolitan Area. The county's leading industrial and commercial activities are located in the village of Newark. The canning and packing of fruits and vegetables is the county's leading manufacturing activity, other important manufacturing activities include polyethylene products, mechanical packing and seals, refrigeration and air conditioning equipment, costume jewelry, paper boxes, furniture, and food products.

Cayuga County is located between the Rochester and Syracuse Metropolitan Areas. The township of Sterling is the only portion of Cayuga County that borders Lake Ontario. The county's principal source of employment is manufacturing with the center of industry concentrated in Auburn. Auburn has both light and heavy industries producing rope and twine, rectifier components, diesel engines, auto ignition replacement parts, molded plastic parts, spark plugs, internal combustion engines, heating and cooling equipment, women's shoes, flat die castings, macaroni products, and feed for poultry and livestock. Other important industries to Cayuga County include printing and publishing.

Oswego County comprises the northern section of the Syracuse Metropolitan Area. The cities of Oswego and Fulton are highly industrialized, with the manufacture of paper and paper products as the major activity

in the county. Other important activities include the manufacture of chocolate products and frozen vegetables, textile-coated products, window shades, alcoholic beverages, and containers. Durable goods produced in Oswego County include gray-iron castings, pulp and paper machinery, aluminum plate, flexible cables, and copper-covered steel wire. The Port of Oswego on Lake Ontario is the leading commercial port on the lake and an important component of trade on the St. Lawrence Seaway.

Jefferson County, located on the eastern end of Lake Ontario, has part of its border adjacent to the St. Lawrence River. Though Jefferson is considered primarily an agricultural county, specializing in dairying, it has a variety of manufacturing concerns. The county's commercial and industrial center is located in its most populous city, Watertown. Other important production in the county includes the manufacture of hydraulic pumps, paper and paper products, paper-making machinery, motors, ski lifts, thermometers, and snow removal equipment. Paper mills are located along the Black River, an important water power source. Proximity to the Adirondack Forest is viewed as important to the paper product industry also.

St. Lawrence County is the largest county in the State with more than 2,700 square miles. It borders the western portion of the St. Lawrence River. The county's proximity to the St. Lawrence power project, Robert Moses Power Dam, installed capacity of 912,000 kilowatts, is a major advantage. The county's location on the St. Lawrence Seaway is also a major advantage. Massena and Ogdensburg are the leading industrial centers of the county, Massena being the State's primary aluminum producer. Other important industries in the county include the extensive pulp and paper mill operations. The largest talc mines in the world are found in St. Lawrence County, as well as a wide variety of minerals including iron ore, zinc, and lead. The Port of Ogdensburg is the leading U.S. harbor in that region. It handles domestic, overseas, and Canadian cargoes.

2.22 AGRICULTURE

Though farm workers constitute a relatively small percentage of the labor force, e.g., agricultural employment for the eight-county study area was 2.5 percent of the total 553,000 employed in 1970, land use devoted to agriculture comprises a major portion of the total land area, especially to rural counties, i.e., Orleans County, 64 percent, Cayuga County, 60 percent. Agriculture plays an important role particularly to the study area shoreline counties of which many are the State's leaders in the production of a variety of selected agricultural products. Scoping the importance of agriculture along the shoreline by MCD boundaries, reveals that over one-third of all persons employed in agriculture in the eight-county study area in 1970 were from the 43 Minor Civil Divisions comprising the Lake Ontario-St. Lawrence River shoreline. Proximity to Lake Ontario serves croplands by modifying temperatures so to retard spring budding and prolong fall growth. Table 2.25 provides agricultural statistics of the study area including land use and trends.

Table 2.25 - Number of Farms, Acreage, and Value of Land and Buildings, by County - 1974

County	Number of Farms		Acres in Farms			
	Total	Class 1-5 Farms[1/]	Total	Percent of Total Land Area	Average Acreage Per Farm	Average Value of Land and Buildings Per Farm
						$
Niagara	1,343	758	159,266	47	119	76,697
Orleans	807	527	161,921	64	201	97,075
Monroe	889	577	141,293	33	159	160,041
Wayne	1,424	888	208,553	54	146	86,082
Cayuga	1,338	995	269,978	60	202	86,860
Oswego	979	529	154,465	25	158	58,989
Jefferson	1,433	1,053	394,247	48	275	85,682
St. Lawrence	1,792	1,262	464,696	26	259	63,739
Eight-County Total	10,005	6,589	1,954,419	38	195	85,674

1/ Farms in the top five economic classes are those which have annual sales of farm products amounting to at least $2,500.

Source: 1974 Census of Agriculture, New York - State and County Data, Vol. 1, Part 32

2.22.1 LAKE ONTARIO-LAKE ERIE FRUIT AND VEGETABLE REGION

Niagara County is part of the Lake Ontario-Lake Erie fruit and vegetable region. This belt covers all of Niagara County and the northern portions of Orleans, Monroe, and Wayne Counties. The northern portion of Niagara County bordering on Lake Ontario and extending south for approximately 20 miles is famous as the Niagara Fruit Belt. In 1974, Niagara County ranked third in the State in the production of sour cherries and fourth in acreage devoted to grapes and apples. Orleans County, along with being an important fruit-producing county, provides vast quantities of onions, cabbage, and tomatoes to nearby processing plants and nearby markets in Buffalo and Rochester. The county ranks second in the State for acres devoted to sour cherries, third in apples, fourth in vegetables, and fifth in potatoes and wheat. As indicated earlier, Monroe County depends less on agriculture for the local economy than other more rural counties in the study area. Though the percentage distribution of those employed in the agriculture sector in Monroe County is the lowest of the eight-county study area (less than 1 percent), the county supported over 2,000 employees in agriculture, a comparable figure with the other shoreline counties. Many fruits and vegetables are grown in the county and a large part of the produce is processed at canning factories in Rochester and areas nearby. Monroe County is a major producer of sour cherries, ranking fourth in the State. One major advantage Monroe County has over the rural fruit and vegetable region counties is its proximity to market areas and its labor supply. Areas such as Monroe County, where intensive land use places pressure on agricultural lands to increase output per acre through technological innovation, reflect a higher efficiency and a more sound and well-established commercial type of agriculture. Consequently, the average value of land and buildings per farm in Monroe County (over $160,000) exceeds all of the remaining shoreline counties by a factor of 1.65 to 2.7. Wayne County is the single most important agricultural county of the fruit and vegetable region leading the State in the production of apples and sour cherries. It is the most important of the eight counties in poultry and products sector, ranking second in the State in the total number of layers. In addition, the county ranks third in total acreage devoted to growing potatoes, which lends diversification to the agricultural sector. Nearly 30 percent of the value of crops sold in the eight-county study area were grown in Wayne County (over $32 million in 1974).

2.22.2 THE SNOW BELT MIXED FARMING REGION

This region contains the northern tip of Cayuga County (Lake Ontario Shoreline) and extends up through Oswego County and southern Jefferson County. The region is devoted mostly to dairying, but some fruits and vegetables are grown on favorable soils. This region typically experiences snowfall averaging above 100 inches a year which leads to drainage problems in the area. Basically, this is a poor agricultural region with few specific advantages.

Cayuga County's principal agricultural activity is dairying. Dairying comprised 46 percent of the county's revenues for the agricultural sector in 1974. Field crops are also important. Cayuga County ranked first in the

State in growing corn for grain. The county also ranks fourth Statewide in the production of oats.

Like Cayuga County, Oswego County depends primarily on dairying. Dairy products amounted to over half of the county's agricultural revenues.

Jefferson County consists of two agricultural regions; the southern portion of the county is a part of the snow belt mixed farming region, while the northwestern portion is representative of the north country dairy region which extends along the shoreline of the St. Lawrence River and includes St. Lawrence County. Jefferson contains the second largest agricultural area of the Lake Ontario-St. Lawrence River shoreline counties; St. Lawrence County containing the largest area and greatest number of farms. The average acreage per farm is 275 acres in Jefferson County, the highest average of the study area counties. This typifies a dairying region whose soil conditions and terrain are suitable for forage crops which are essential for grazing.

St. Lawrence County and Jefferson County lead the State in total number of cattle, calves, milk cows, corn for silage, and hay. In addition, Jefferson County ranks second in the production of oats. Both counties singularly grossed over $32 million in dairy products in 1974.

2.22.3 AGRICULTURE OUTLOOK

The agricultural trend in New York State through the twentieth century generally reflects a push for more intensified land use with the opportunity cost of alternative land use rising. The opportunity cost confronting average farmers also included the rising wages offered by other growing industrial concerns. Hence, many unsuccessful farmers sold their farming concerns to neighboring farms, moving their families to urban centers. With the total number of farms decreasing and the average size per farm rising, coupled with growing technological advancement, output per acre and total production continued to rise. The future of the agricultural sector in New York State will remain a healthy one. The number of jobs in agriculture has been projected to grow, however, most of this increase will be concentrated in the horticultural and agricultural services industries, e.g., landscape gardening, animal hospitals, and other veterinary services rather than other agricultural production sectors. The number of farmers and farm workers are projected to decline. However, agricultural production and number of non-farming agricultural workers should still rise. In the coming decade, demand for food will grow rapidly, thus strengthening job prospects in this sector.

2.23 TRANSPORTATION

The transportation system has played an important role in shaping the development of Upstate New York. Prior to the development of railroads and automobiles, industry and commerce in the area located at the water's edge. Consequently, urbanization evolved primarily around the periphery of water ports. The construction of barge canals, e.g., Erie, Oswego, Black River, Cayuga, and Seneca, in the nineteenth century enabled farmers in the rich agricultural regions just south of Lake Ontario to more easily transport

their produce to neighboring markets. The development of roads and railroads permitted villages to expand in locations away from water access. The steam railroad in the early nineteenth century facilitated the hauling of heavy loads of the manufacturing industries and raw materials within urban areas. 1/

Two interstate highways in the proximity of the study area are I-90 (the Governor Thomas E. Dewey Thruway), and I-81. I-90 follows the east-west corridor of the railroad and canal and traverses between Buffalo, NY, and Albany, NY, connecting Rochester, NY, Utica, NY, and Syracuse, NY. I-81 is a north-south route traversing New York State from Binghamton, through Syracuse, Watertown, and ending at the bridge to Canada near the western end of the St. Lawrence River. Table 2.26 depicts selected principle through highways within the study area counties.

2.24 NAVIGATION

2.24.1 GENERAL

Lake Ontario is an integral part of the Great Lakes-St. Lawrence Seaway System. Active deep-draft commercial port facilities in New York State on Lake Ontario and the St. Lawrence River include Rochester Harbor, Oswego Harbor, and Ogdensburg Harbor, which allow access to the system.

St. Lawrence Seaway, the Great Lakes and ports, the Gulf of St. Lawrence, and the St. Lawrence River together form 2,342 miles of continuous waterway suitable for deep-draft, ocean-going vessels. The St. Lawrence Seaway, opened to traffic in July 1958, consists of the St. Lawrence River between Montreal and Lake Ontario and the Welland Canal which connects Lake Ontario to Lake Erie. The Seaway is operated bilaterally by the St. Lawrence Seaway Development Corporation of the United States and St. Lawrence Seaway Authority of Canada. The Seaway provides for navigation of general cargo vessels carrying up to 8,500 tons of cargo and for lake bulk-type vessels carrying up to 30,000 tons of cargo. The Seaway System includes seven locks on the St. Lawrence River and eight locks on the Welland Canal. The U. S. maintains two locks in the International Section of the Seaway, the Snell and Eisenhower Locks, and the Canadians operate the remainder. Maximum dimensions of ships permitted in the locks are: length - 730 feet, breadth - 75.5 feet, and draft - 26.0 feet. The navigation season of the Seaway is restricted by weather and is typically open from mid-April to mid-December. Speed restrictions in the Seaway and time spent in entering, in being raised or lowered, and in leaving the 15 locks in the system add considerable time to a voyage. Average speed from Montreal to Ogdensburg is about 6.5 mph; Montreal to Oswego about 6.9 mph, and Montreal to Rochester about 7.4 mph.

1/ R. Bish and H. Nourse, Urban Economics and Policy Analysis, "Urban Transportation."

Table 2.26 - Selected Principle Thru Highways of the Lake Ontario - St. Lawrence River Area

County	Route	Primary Directions
Niagara	Rt. 18	East-West
	Rt. 78	North-South
	Rt. 104	East-West
	Rt. 31	East-West
Orleans	Rt. 63	North-South
	Rt. 18	East-West
	Rt. 104	East-West
	L. Ontario State Pkwy.	East-West
	Rt. 31	East-West
	Rt. 98	North-South
Monroe	Rt. 104	East-West
	Rt. 18	East-West
	Rt. 19	North-South
	Rt. 31	East-West
	Rt. 15	North-South
	Interstate 490	North-South
	L. Ontario State Pkwy.	East-West
Wayne	Rt. 104	East-West
	Rt. 21	North-South
	Rt. 88	North-South
	Rt. 14	North-South
	Rt. 89	North-South
	Rt. 31	East-West
Cayuga	Rt. 104	East-West
	Rt. 38	North-South
	Rt. 370	East-West
	Rt. 34	North-South
Oswego	Rt. 104	East-West
	Rt. 49	East-West
	Rt. 481	North-South
	Rt. 3	North-South
	Rt. 11	North-South
	Rt. 69	East-West
	Rt. 13	East-West
	Rt. 48	North-South
Jefferson	Rt. 3	North-South
	Rt. 11	North-South
	Rt. 178	East-West
	Rt. 12	North-South
	Rt. 12E	East-West
	Rt. 37	North-South
	Rt. 283	East-West
St. Lawrence	Rt. 37	East-West
	Rt. 11	East-West
	Rt. 87	North-South
	Rt. 345	North-South
	Rt. 56	North-South
	Rt. 420	North-South
	Rt. 95	North-South
	Rt. 30	North-South
	Rt. 11B	North-South

2.24.2 PORT OF ROCHESTER

The Port of Rochester is located about 1/2 mile from the open waters of Lake Ontario. Federal project depth for the 300-foot wide lake approach channel is 24 feet, and 23 feet for the 200-foot wide entrance channel between the harbor breakwater piers. Project depth at the Port of Rochester and the 600-foot wide turning basin is also 23 feet deep. There is no navigable connection on the Genesee River between Lake Ontario and the New York State Barge Canal System. Maximum annual water level fluctuations recorded for Lake Ontario is 3.58 feet. Currents do not adversely affect sailing in the harbor. A marginal wharf of 1,282 feet in length provides berthing facilities for two general cargo ships in the 500 to 550 foot range. Dry bulk cargo can be unloaded by a self-unloader at the south end of the wharf.

The physical plant consists of three buildings for storage totaling 102,200 square feet. Two railroad sidings provide direct connection to the Conrail lines. Open storage amounts to approximately 11 acres, and crane rental is available as necessary. Truck access from the port facilities to major highway arteries is possible through suburban residential areas.

Commerce via Rochester Harbor has been steadily declining in the past decade. Rochester Portland Cement Company, which receives raw cement for distribution, is the only major company which engages in waterborne commerce at Rochester Harbor. Previous activities at the port included the Rochester-Monroe County Port Authority which handled dry bulk and general cargo at the port before being abolished in 1976. The Genesee Coal Dock, ceased operation in 1970. Table 2.27 shows the historical tonnage, by commodity, handled at Rochester Harbor.

It is evident from Table 2.27 that the most stable user of the harbor facilities has been the Rochester Portland Cement Company. This company employs 72 workers and serves customers within a 50-mile radius of their storage silos. The dock is located near the upstream Federal project limit where cement is unloaded by vessel and shipped by truck to individual sites. The facility has the capacity to receive by either rail or truck as well as water. Future waterborne commerce at Rochester Harbor is dependent directly on rate differential alternative modes of shipping (i.e., water rates versus rail or truck rates). The future of the port is now uncertain. Alternatives range from a total phase-out of port activities and a redevelopment of the area into passive recreation use to an expansion of port facilities, maintaining rail linkages, and dredging of the existing channels. One future scenario for port activity includes the provision of ferry service from Rochester to Canada.

2.24.3 PORT OF OSWEGO

Located at the mouth of the Oswego River, the port provides transportation services for local industry, as well as serving the Syracuse Metropolitan Area. The Port of Oswego owns three terminal facilities. A general cargo and bulk wharf, 1,800 feet in length, located on the east side, is capable of handling three - 500-foot length range vessels simultaneously

Table 2.27 - Rochester Harbor, Historical Tonnages, by Commodity

	Cement	Salt	Newsprint	Coal	Other	Total
1977	190,524	-	-	-	15,933 1/	206,457
1976	210,656	-	-	-	10	210,666
1975	220,990	-	-	-	-	220,990
1974	265,497	44,383	-	-	6	309,886
1973	265,472	39,400	16,154	-	112,922	433,948
1972	273,399	73,100	19,637	-	149	366,285
1971	182,220	106,800	15,345	-	2,884	307,249
1970	174,198	66,933	14,634	169,539	23,822	449,126
1969	127,917	30,500	13,041	433,431	4,749	609,638
1968	184,712	46,261	11,127	405,427	45,635	693,162
1967	158,393	38,738	15,974	410,695	61,413	685,213
1966	150,117	63,369	16,606	515,259	38,151	839,502
1965	123,419	10,635	11,638	606,479	9,259	761,430

1/ Logged entry of iron ore import was probably misallocated and is incorrect.

Source: Waterborne Commerce of the United States, Part 3, Waterways and Harbors, Great Lakes, Corps of Engineers, 1965-1977.

on the west bank. There is also a grain elevator facility, 1,000 feet long, which can berth two ships. Additionally, dry and liquid bulk cargo is handled at this facility. Currently inactive is the 1,000-foot Erie-Lackawanna Railroad Coal Dock, which has deteriorated somewhat due to lack of upkeep. The physical plant consists of a 100,000 square foot transit shed, a 28,000 square foot covered bulk storage building, and approximately 9 acres of open storage area (east terminal), a 1,038,000 bushel grain elevator, and a 28,500 square foot covered bulk storage building (west terminal). Mechanical equipment includes a conveyor, payloader, fork lift trucks, and cranes. Railroad access to the wharf connects the east side terminal to the Conrail railroad system. The Conrail Corporation additionally owns a section of track which services the grain elevator at the west terminal and is scheduled for abandonment. Local business and residential streets connect a truck route into State Road 57 to port facilities. State Road 57 connects directly into Interstate Routes I-81 and I-90.

Waterborne commerce at the Port of Oswego has fluctuated on a year-to-year basis. Waterborne commerce records since 1965 indicate that commodity traffic at Oswego has varied from an annual volume of 25,860 tons in 1968 to 135,883 tons in 1965. Principal port users include Niagara Mohawk Power Corporation which imports fuel oil from Canada for its generating plant located directly west of the Federal project, Huron Cement, which handles cement from Canada for distribution, Metropolitan Petroleum Company, which distributes petroleum products, and the Oswego Port Authority which imports and exports general cargo. The Port of Oswego was a key factor in locating the Alcan Aluminum Rolling Mill which employs over 500 residents in the Oswego area. Aluminum ingots and billets are shipped by rail directly to the Port Authority. Historical waterborne commerce tonnage movements are exhibited in Table 2.28. In addition to handling Seaway traffic, the Port of Oswego connects with the New State Barge Canal System through the Oswego Canal.

2.24.4 PORT OF OGDENSBURG

The Port of Ogdensburg is situated on the St. Lawrence River about one-quarter mile from the Seaway channel. The Port Authority Dock is located adjacent to the 250-foot wide lower east entrance channel which has a Federal project depth of 19 feet. The Port Authority has dredged an entrance channel of 28 feet, and the 27 feet of water alongside the dock equals the Seaway limit. Currents in the St. Lawrence River do not adversely affect shipping at the terminal.

The Ogdensburg Bridge and Port Authority (OBPA) operates a marine terminal dock and warehouse complex. The completion of this improvement project placed the port as the only U.S. harbor on the St. Lawrence River capable of handling "Seaway" type bulk carriers and overseas general cargo vessels. Commodities handled through OBPA typically include mixed general cargo, dry bulk, and bulk fuel oil. OBPA is the sole exporting corporation at the port.

Berthing facilities include a single, general cargo berth 600 feet in length. The Port Authority terminal was opened in 1971 and enables the handling of all sizes of Great Lakes and overseas vessels. About 1,200 feet

Table 2.28 - Oswego Harbor, Historical Tonnages, by Commodity

	Cement	Petroleum Products	Grain	Other	Total
1977	115,915	1,189,258	19,747	21,192	1,346,112
1976	134,279	820,068	24,276	35,512	1,014,135
1975	145,315	653,441	25,764	23,467	847,987
1974	114,830	723,836	23,537	40,140	902,343
1973	177,246	650,928	23,678	79,025	930,877
1972	187,765	469,758	33,991	87,903	779,417
1971	248,636	164,775	41,159	36,624	491,196
1970	231,824	167,518	34,328	39,883	473,553
1969	211,164	169,849	31,827	11,472	424,312
1968	183,932	92,707	31,049	72,345	380,033
1967	174,782	102,736	37,516	27,184	342,218
1966	166,612	61,956	159,031	61,555	449,154
1965	118,325	33,591	31,209	69,441	252,566

Source: Waterborne Commerce of the United States, Part 3, Waterways and Harbors, Great Lakes, Corps of Engineers, 1965-1977.

of shoreline is used for the anchoring of self-unloading bulk carriers. The general cargo berth is capable of unloading petroleum products and some dry bulk cargo. Physical plant facilities at Ogdensburg include two transit sheds, each with areas of about 1,200 square feet. Additionally, a 20,000 square foot warehouse is utilized, and a 40,000 square foot warehouse is leased for storage. Open dry bulk storage is available on more than 8 acres of land set aside for that purpose. A 500,000-bushel grain elevator is no longer in operation. Cranes are rented locally as required. Truck access to facilities is possible via local residential streets to State Road 57, and a single track railroad terminates on the port facility. Historical water-borne commerce tonnage movements are exhibited in Table 2.29.

There are only three active dock operators at the Port of Ogdensburg: Mobil Oil Corporation, Augsbury Corporation, and the Ogdensburg Bridge and Port Authority. Mobil Oil Corporation maintains a small dock located on the western side of the upper entrance channel. Total tank storage capacity is estimated at 190,000 barrels and consists of gasoline, kerosene, and fuel oils. Petroleum products shipped to Ogdensburg via the Great Lakes originate from refineries in Buffalo, NY, Toledo, OH, and Trenton, MI. In recent years, Mobil Oil docks at Ogdensburg received on average 31,000 tons of petroleum products annually. Seven thousand tons of this average total movement takes place on inland waterways, i.e., the New York State Barge Canal. Augsbury Corporation operates a dock located adjacent to the city front channel and receives petroleum and bulk salt. In recent years, commodity flows at Augsbury have fluctuated a great deal; total tonnages vary from 51,000 tons in 1972 to 129,000 in 1973 with average volumes between 1971 and 1977 of 87,000 tons.

2.24.5 CANALS

The New York State Barge Canal, which traverses the State from the Niagara Frontier to the Hudson River, allows cheap, energy-saving water transportation to almost every corner of New York State. Proximity of the Upstate New York deepwater ports to the Barge Canal System form the backbone of water-based transportation within the State.

The entire Barge Canal System is 527 miles long and is now used primarily for recreational boating. Its commercial importance has declined though heating oil and other petroleum products are still important commodities on the Canal. Current regulation of the Barge Canal derives other benefits to New York State which include flood control, irrigation, and municipal water supply. The Port of Oswego is the only Lake Ontario port which directly connects into the Barge Canal System through the Oswego Canal, i.e., Oswego River. Future development of the Canal System is uncertain. New York State is attempting to receive Federal assistance for both maintenance and operation of the New York State Barge Canal.

2.25 RECREATIONAL RESOURCES

The coastal boundaries of New York State with its beaches, bluffs, sand dunes, inlets, and bays provide a multitude of water dependent and enhanced activities during all seasons of the year. The recreational use of Lake

Table 2.29 - Ogdensburg Harbor, Historical Tonnages

Year	Tons
1977	257,443
1976	221,402
1975	235,448
1974	214,944
1973	280,039
1972	215,542
1971	237,557
1970	265,558
1969	287,217
1968	299,931
1967	300,156
1966	341,197
1965	358,200

Source: Waterborne Commerce of the United States, Part 3, Waterways and Harbors, Great Lakes, Corps of Engineers, 1977, 1973.

Ontario is relatively small compared with the other Great Lakes. In spite of this, the Lake Ontario Shoreline is the most heavily utilized recreation area in New York State. 1/ The various recreational activities provided for by Lake Ontario contribute significantly to the State's economy with many coastal communities depending on the recreation industry for their economic existence.

2.25.1 SUPPLY OF OUTDOOR RECREATION

In March of 1978, the New York State Office of Parks and Recreation had completed the New York Outdoor Recreation Facilities Inventory for the New York State Coastal Management Program. Recreation facilities were inventoried for all counties located in New York State's coastal zone. The inventory is a compilation of information on public and private recreation sites within the coastal zone. The following is an overview of that report geared specifically to the coastal zone of Lake Ontario and the St. Lawrence River.

Data indicated that commercial enterprise predominates in the Great Lakes/St. Lawrence River areas with over 70 percent of the recreation being provided by commercial operators. Boat marinas, launch areas, and boat rentals dominate the recreation industry in the same region with 30 percent of the enterprise. Data for the Great Lakes/St. Lawrence River region indicates that unlike the remaining regions in New York State's coastal zone, i.e., Hudson River Valley and New York City region, there are large amounts of shoreline beach area as well as camping facilities, especially in the Thousand Islands region. This region contains a large number of State park facilities.

2.25.2 STATE PARKS AND MARINAS

Twelve State parks are situated amidst the bluffs and harbors of Lake Ontario. Picnicking, boating, fishing, camping, and winter sport activities prevail at these water-based facilities. Scenic areas dominate the State parks of Selkirk Shores (Oswego County), Chimney Bluffs (Wayne County), and Fair Haven Beach (Cayuga County). A string of 17 State parks border the eastern end of Lake Ontario and the St. Lawrence River. These State parks offer the greatest diversity of facilities and activities. Nearly all contain campgrounds and swimming beaches and many are oriented toward boating with launch and/or mooring facilities. Picnicking for day users, fishing and hunting access, and hiking trails are common throughout the parks system. Temperature and snow cover during the winter months provide excellent conditions for ice fishing, cross-country skiing, and snowmobiling. Table 2.30 lists the State-owned and/or operated marine parks and boat launching sites along Lake Ontario and the St. Lawrence River. Table 2.31 presents each State park by shoreline county along with acreage and attendance figures.

Tables 2.32 and 2.33 present summary figures by activity obtained from the New York State Office of Parks and Recreation's Public Access and Recreation Within the Coastal Boundaries of New York State.

1/ New York State Coastal Management Program, March 1979.

Table 2.30 - State-Owned and/or Operated Marina Parks (MP) and Boat Launching Sites (BLS)

Orleans	
	Oak Orchard MP
Monroe	
	Irondequoit Bay MP
Oswego	
	Mexico Point BLS 1/
Jefferson	
	Chaumont Bay BLS 1/
	Stony Creek BLS 1/

1/ Property owned by municipality, operated by OPR.

Source: NYS Office of Parks and Recreation, Public Access and Recreation Within the Coastal Boundaries of New York State, 1978.

Table 2.31 - State Parks Within the Coastal Zone of Lake Ontario and the St. Lawrence River

Acerage and Fiscal Year Attendance 1955-1976

State Park	Acres	Year Estab-lished	Attendance (000) 1955	1960	1965	1970	1971	1972	1973	1974	1975	1976
Niagara County												
Fort Niagara S.P.	504	1947	309	336	350	550	666	683	651	638	623	677
Four Mile Creek S.P.	248	1961			60	72	59	58	63	57	62	64
Golden Hill S.P.	510	1962			6	8	6	6	5	5	6	5
Wilson-Tuscarora S.P.	390	1965					UNDEVELOPED					
Orleans County												
Lakeside Beach S.P.	734	1962			2	36	25	23	38	52	51	55
Monroe County												
Braddock Bay S.P.	2,294	1956	1	11	21	29	29	31	33	38	39	45
Hamlin Beach S.P.	1,243	1937	300	274	265	328	294	316	380	355	327	354
Wayne County												
Chimney Bluffs S.P.	596	1962					UNDEVELOPED					
Cayuga County												
Fair Haven Beach S.P.	864	1928	294	281	289	289	240	228	242	225	316	229
Oswego County												
Selkirk Shores S.P.	980	1926	132	168	158	196	160	145	166	164	155	188
Jefferson County												
Burnham Point S.P.	12	1898	15	20	16	18	23	17	19	16	13	13
Canoe Pt. & Picnic Pt. S.P.	70	1898	9	10	12	17	10	7	7	8	6	6
Cedar Point S.P.	48	1936	64	70	83	100	76	81	84	80	80	81
DeWolf Point S.P.	13	1898	12	10	7	6	5	7	5	6	8	6
Grass Point S.P.	66	1926	59	66	56	37	40	24	22	34	30	28
Keewaydin S.P.	179	1962			11	32	30	33	40	45	36	23
Kring Point S.P.	61	1898	36	48	51	54	48	48	52	53	50	40
Long Point S.P.	23	1913	13	13	16	17	21	23	18	18	18	18
Mary Island S.P.	13	1898	5	3	6	8	6	5	3	5	8	5
Southwick Beach S.P.	472	1966				80	69	61	78	70	67	68
Waterson Point S.P.	6	1898	5	3	4	3	4	3	3	3	5	3
Wellesley Is. S.P.	2,636	1951	25	96	176	219	219	208	243	242	252	237
Wescott Beach S.P.	319	1945	132	143	161	191	163	150	175	141	135	110
St. Lawrence County												
Cedar Is. S.P.	10	1898	5	3	3	3	3	1	2	1		
Coles Creek S.P.	1,800	1958				Included with Robert Moses						
Croil Is. S.P.	796	1970				2	3	3	3	1		
Galop Is. S.P.	675	1969				8	9	8	9	2		
Jacques Cartier S.P.	461	1957	36	35	71	75	72	41	50	49	44	36
Robert Moses S.P.	2,267	1958		177	184	439	368	343	339	278	334	371
St. Lawrence S.P.	316	1968				11	13	12	15	16	17	20

Source: NYS Office of Parks and Recreation, Public Access and Recreation Within the Coastal Boundaries of New York State, 1978.

Table 2.32 - Beaches, Boat Marinas, and Launch Area Facilities

	Feet of Shoreline Beach	No. of Cartop Launch Areas	No. of Launch Ramps	No. of Pier Moorings	No. of Anchorage Moorings	No. of Transient Moorings	No. of Storage Facilities
Cayuga	1,900	2	14	545	87	27	660
Jefferson	15,850	3	62	3,276	31	241	120
Monroe	3,500	1	10	1,748	2	3	315
Niagara	1,500	-	19	704	4	6	200
Orleans	750	1	2	568	1	12	-
Oswego	4,610	-	16	107	17	26	170
St. Lawrence	3,120	5	30	523	1	42	185
Wayne	180	4	13	596	122	55	707
Total	31,410	16	166	8,067	265	412	2,357

Source: NYS Office of Parks and Recreation, Public Access and Recreation Within the Coastal Boundaries of New York State, 1978.

Table 2.33 - Picnicking, Camping, and Natural and Scenic Areas

	Picnicking		Camping		Natural and Scenic Areas	
	No. of Picnic Tables	No. of Acres	No. of Vehicle Sites	No. of Tent Sites	No. of Natural and Scenic Areas	No. of Nature Centers
Cayuga	788	46	688	3	-	-
Jefferson	1,010	56	1,804	49	4	3
Monroe	4,512	31	266	-	6	2
Niagara	2,024	58	582	-	2	-
Orleans	36	5	748	80	-	-
Oswego	688	20	1,685	-	6	-
St. Lawrence	689	18	968	319	11	-
Wayne	138	10	110	-	2	-
Total	9,885	244	6,851	451	31	5

Source: NYS Office of Parks and Recreation, Public Access and Recreation Within the Coastal Boundaries of New York State, 1978.

2.25.3 DEMAND FOR OUTDOOR RECREATION

Recreation demand can be defined as the quantity of outdoor recreation opportunity an individual desires or needs. In economic terms, it is the measure of the quantity of outdoor recreation opportunities the individual is willing and able to pay for at one point in time with a given level of opportunity conditions.

Demand basically comprises two components: (1) The expressed demand represented by the use of existing facilities and (2) the latent or unexpressed demand which is inherent in a population but not reflected in the use of existing facilities. 1/

Measuring demand for various recreational activities involves the complicated task of identifying, quantifying, and analyzing those components which best explain or influence a population to participate or desire to participate in the recreational activity. Though the state of the art is yet in its infancy stage, numerous surveys and studies have developed mathematical models which utilize what has been found to be the most important explanatory factors in influencing the desire to participate in recreational activities. Hence demand future participation changes in various socio-economic and demographic characteristics of a region, i.e., population, population density, median age, family size, home ownership, leisure time, income, and mobility affect future participation rates in outdoor recreation. Even if individual recreational activity preferences remain unchanged, absolute levels of demand will grow simply because of the growth in population. Preference patterns are also expected to change as the socio-economic characteristics of the population change.

An increase in the median age of the population will be the greatest general deterrent to participation increases in forms of outdoor recreation, especially those which are more physically demanding. Changes in median age are expected to vary in different parts of the State. Suburban communities of moderate density will be most adversely affected due to rising median age. These communities are currently receiving a high in-migration of largely middle-aged and upper-aged citizens, who are former city residents. Conversely, the median age in urban and rural areas will level off or slightly drop. The result will be a resurgence in recreational participation rates. Rises in income will be one of the socio-economic factors that will exhibit the greatest force in rising participation rates, particularly for the more expensive activities such as boating. Growth in income and population will occur greatest in suburban and exurban areas.

Outdoor recreation demands will reflect the growth of both of these factors. In general, newly urbanizing areas will consistently have the highest growth in demand in nearly all recreational activities. Other factors affecting future participation rates include availability of leisure time, population density, home ownership, and family size. Estimates of

1/ Lake Ontario Basin Water-Oriented Outdoor Recreation.

future levels of leisure time vary by sizable margins. It is deemed more reasonable to expect only moderate increases in leisure time, assuming a continuation of present productivity trends. Expected increases in population density and decreases in family size and home ownership rates will have a variety of effects on participation in different activities. The effects will be most noticeable in those areas where they are subject to the most change.

Other factors, not socio-economically or demographically related, also may affect participation rates in outdoor recreation activities. The major factor is the supply accessibility variable. At present, greater participation in the central cities is prevented largely because of congestion on urban highway systems leading to major recreation areas and the limited number of facilities accessible by mass transit. Distance is a major component in the supply accessibility variable. Many recreation sites are scattered along the rural shore zone of eastern Lake Ontario and the St. Lawrence River. Changes in participation from a rise in income may be partially offset by an increase in operating costs for motor vehicles.

Tables 2.34a through 2.34e exhibit demand figures which resulted from a mathematical model that utilized those factors considered the most explanatory in affecting participation. The figures were calculated by New York State Office of Parks and Recreation for the State Coastal Management Program. They represent demand by selected activity and county for the years 1975 and 2000 on a peak day use basis. Also provided are existing capacities based on minor civil divisions located within the coastal boundaries of each shoreline county. Capacities are calculated from the outdoor recreation facilities inventory by NYSOPR, and represent the maximum number of people that may be served by the county's organized coastal recreational facilities on a given day. Activities include swimming, boating, fishing, picnicking, and camping.

2.25.4 RECREATION NAVIGATION

Recreational boating is considered to be one of the major outdoor recreational industries in New York State. 1/ This activity is one of the most expensive, requiring considerable investment in equipment. Boating embraces many forms, from sailing of both cruising and day vessels through various sized powered vessels, small dinghies, rowboats, canoes, and paddle boats. Department of Motor Vehicles data indicates that the total number of registered vessels in the Great Lakes - St. Lawrence region counties was 77,637 as of December of 1976 or 23 percent of all registered boats in New York State. This did not reflect the total number of boats in use at that

1/ A study conducted by Dick Noden and Tommy Brown, The New York Commercial Marina and Boatyard Industry, 1972, estimated that gross revenues of all commercial marinas and boatyards within the Great Lakes - St. Lawrence region to be about $10 million in 1972.

Table 2.34 - Current and Forecast Outdoor Recreation Demand

a

Swimming	Users - 1975	Users - 2000	Present Capacity
Cayuga	828	1,030	1,504
Jefferson	13,665	18,673	48,656
Monroe	67,023	83,129	20,326
Niagara	33,452	33,982	20,928
Orleans	2,272	3,075	3,914
Oswego	14,001	22,216	24,574
St. Lawrence	10,751	15,669	21,410
Wayne	1,515	2,139	1,215

b

Boating	Users - 1975	Users - 2000	Present Capacity
Cayuga	279	341	723
Jefferson	5,008	6,691	31,350
Monroe	20,740	26,086	19,546
Niagara	13,018	13,377	23,050
Orleans	841	1,131	2,165
Oswego	3,799	5,903	9,349
St. Lawrence	3,308	4,736	13,624
Wayne	1,526	2,095	3,520

Table 2.34 - Current and Forecast Outdoor Recreation Demand (Cont'd)

c

	Fishing		
	Users - 1975	Users - 2000	Present Capacity
Cayuga	21	22	63
Jefferson	438	489	2,200
Monroe	1,252	1,311	1,526
Niagara	984	901	2,007
Orleans	82	90	315
Oswego	340	422	1,125
St. Lawrence	492	568	3,465
Wayne	84	97	230

d

	Picnicking		
	Users - 1975	Users - 2000	Present Capacity
Cayuga	284	319	687
Jefferson	3,963	4,905	8,900
Monroe	5,701	6,231	3,845
Niagara	13,520	12,551	24,893
Orleans	368	455	1,087
Oswego	4,733	6,883	8,888
St. Lawrence	4,297	5,657	7,438
Wayne	694	894	1,129

Table 2.34 - Current and Forecast Outdoor Recreation Demand (Cont'd)

e

	Camping		
	Users - 1975	Users - 2000	Present Capacity
Cayuga	281	299	187
Jefferson	8,664	9,332	7,290
Monroe	2,086	2,181	1,164
Niagara	5,944	5,916	4,216
Orleans	1,530	1,611	1,244
Oswego	7,568	8,320	5,501
St. Lawrence	4,809	5,297	4,646
Wayne	802	863	554

time due to the fact that New York State requires only mechanically propelled vessels to be registered and therefore excludes unpowered vessels, e.g., sailboats (without auxiliary motors), rowboats, paddle boats and canoes, and documented vessels. Tables 2.35 and 2.36 display registration data by class of boat, county of residence, and county of use for shoreline counties bordering Lake Ontario and St. Lawrence River. As the tables indicate, the less than 16-foot length class vessels dominate along Lake Ontario and St. Lawrence River with 67 percent of the total vessels registered. Sixteen-foot to 26-foot length class vessels follow, totaling about 30 percent.

Table 2.36 presents a tabulation of vessels by class dispersal associated with use. It shows the movement of vessels from one region to another. These changes may be due to a number of factors such as ownership or rental of summer facilities away from home, lack of local facilities, absence of suitable waters, or unique attractiveness of areas into which visitors migrate. Analysis of New York State Boating 12/1/76 through 12/31/79, prepared by NYSOPR in 1977 for the 3rd Year Coastal Management Program, examines boating characteristics for the entire State. Pleasure boating is the major activity of use (92 percent) with dealer and rental uses following.

The greatest number of vessels in New York are owned by persons in the 46 to 50 year age bracket followed by owners in the 41 to 45, 31 to 35, 36 to 40, 51 to 55, 26 to 30, 61 to 65, and 56 to 60 year age bracket, respectively, with the latter seven groups having only minor percentile differences. Fiberglass is the most popular hull material preferenced over aluminum and wood. Outboards comprise 80 percent of all registered vessels, followed by inboards and inboard/outdrive vessels.

2.25.5 COMMERCIAL, MUNICIPAL, PRIVATE, AND STATE BOATING FACILITIES

There were approximately 140 commercial and municipal boatyards and marinas with 10 or more known berthings in the shore zone boundary counties of Lake Ontario and the St. Lawrence River when inventoried in 1972. 2/ Table 2.37 presents numbers and characteristics of the listed operations by county.

The lack of suitable pierside moorings, and adequate number of harbors of refuge along certain areas of the coastal boundaries of New York State, is a problem recognized by NYSOPR. Many piers now being used are not suitable

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1/ A study conducted by Dick Noden and Tommy Brown, The New York Commercial Marina and Boatyard Industry, 1972, estimated that gross revenues of all commercial marinas and boatyards within the Great Lakes - St. Lawrence region to be about $10 million in 1972.

2/ Data extracted from The New York Commercial Marina and Boatyard Industry, 1972.

Table 2.35 - Class of Boat by County of Residence
12/76 - 12/79

County	Class						
	16' and Less	16' to 26'	26' to 40'	40' to 65'	Greater than 65'	Uncoded	Total
Cayuga	2,284	750	58	2	1	14	3,109
Jefferson	3,966	1,977	231	17	0	53	6,244
Monroe	12,464	6,863	790	30	2	57	20,206
Niagara	4,028	2,015	247	7	2	28	6,327
Orleans	736	194	32	1	0	10	973
Oswego	3,557	1,178	102	7	0	7	4,851
St. Lawrence	4,908	1,093	70	11	0	23	6,105
Wayne	2,235	1,073	103	5	0	6	3,422
Total	34,178	15,143	1,633	80	5	198	51,237

Source: Analysis of New York State Boating 12/1/76 through 12/31/79, Table 1, Office of Parks and Recreation, Planning Bureau, June, 1977.

Table 2.36 - Class of Boat by County of Use
12/76 - 12/79

County	Class						
	16' and Less	16' to 26'	26' to 40'	40' to 65'	Greater than 65'	Uncoded	Total
Cayuga	3,114	1,110	151	6	1	5	4,387
Jefferson	6,104	4,062	507	48	0	39	10,760
Monroe	7,121	3,983	517	14	2	21	11,658
Niagara	3,548	1,848	288	6	2	8	5,700
Orleans	932	371	43	1	1	5	1,353
Oswego	4,566	1,806	155	12	0	7	6,546
St. Lawrence	6,222	1,622	102	14	1	12	7,973
Wayne	2,561	1,360	179	4	0	4	4,108
Total	34,168	16,162	1,942	105	7	101	52,485

Source: _Analysis of New York State Boating 12/1/76 through 12/31/79_, Table 1, Office of Parks and Recreation, Planning Bureau, June, 1977.

Table 2.37 - Commercial, Municipal, Private, and State Boating Facilities (With 10 or More Known Berthing)

County	Commercial				Municipal 1/			
	Marinas and Boatyards 2/	Berthing Moorings	Berthing Slips	Other Marine Facilities 3/	Marinas 2/	Berthing Moorings	Berthing Slips	Launching Sites
Niagara	9	-	622	12	1	-	11	6
Orleans	2	-	40	8	-	-	-	-
Monroe	13	2	1,084	4	2	(No Data)		1
Wayne	3	80	60	14	-	-	-	1
Cayuga	10	52	491	6	1	-	40	1
Oswego	6	-	516	14	-	-	-	-
Jefferson	54	54	2,781	33	2	-	100	4
St. Lawrence	12	45	425	17	1	-	10	10
Total	119	233	6,019	108	7	-	161	23
Expanded Total 4/	140	260	6,832					

1/ Municipal also includes: county, city, village, town, Federal, school districts, quasi-public, and nonprofit or community service organizations.
2/ The majority of these marinas or boatyards also include launching facilities.
3/ Other marine facilities include: launching sites, gas docks, boat rentals and charters, boat repair yards, fish stations, motels, camps, cottages, restaurants, etc., and the small berthing capacity associated with these types of facilities is most often directly related to the business or facility and not offered as seasonal rentals to the boating public and therefore not included in these data. Also, locations listed on the inventory but offering no facilities or services were excluded.
4/ The State marine facility inventory lists a small percentage of commercial firms and private yacht clubs with berthing capacities unknown. Therefore, totals were expanded to reflect those operations based on average values of the total.

Source: The New York Commercial Marina and Boatyard Industry, 1972.

for continued use because of age and badly deteriorated conditions. In other areas, marine facilities are not readily accessible to population centers. The State encourages municipalities on coastal waters to participate in joint development of marine facilities. In spite of local interest, progress is slow. The State program calls for continued maintenance, improvement, and expansion of marine facilities within the State park areas.

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SECTION 3
FUTURE CONDITIONS

LAKE ONTARIO SHORELINE PROTECTION STUDY

SECTION 3

FUTURE CONDITIONS

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SECTION 3 - FUTURE CONDITIONS

The purpose of this section is to present a look at future conditions and to assess the direction of future development of Lake Ontario resources. These future conditions serve to define a basis upon which impacts of development plans can be measured. This is commonly referred to as the "without project" condition. Future conditions also serve to identify possible problems or needs which may not be apparent when analyzing existing conditions.

As the study progresses through Stages 2 and 3, alternative future conditions will be projected. From this range of alternative futures, the one which best reflects the constraints imposed by the economic, social, environmental, and political systems, will serve as the "most probable future" for describing the "without project" condition.

The scope of Stage 1 has limited the identification of alternative futures to that of existing literature where little discussion could be found relative to alternative projections. What follows is basically a very preliminary identification of the "most probable future" conditions along the Lake Ontario shoreline. This discussion is tempered with the knowledge that subsequent studies will refine the discussion and provide more accurate projections.

3.1 POPULATION

Projections of future population totals are of utmost importance in any planning program. Armed with knowledgeable forecasts of growth, communities can prepare effectively to provide for services and facilities needed to accommodate future residents.

The major growth areas along the Lake Ontario shoreline are Orleans, Monroe, and Wayne Counties. The largest growth rates for the (1980-2030) (Table 3.1) period are evidenced in Wayne County, to the east of Monroe County and the Rochester SMSA. The area is probably growing as a direct influence of the growth "pull" of the SMSA. Indeed, development in this area is strongest in those counties clustered around the Rochester SMSA.

Monroe County, the population center for the entire Lake Ontario shoreline, is expected to continue to grow but not at the rates of population growth experienced during the 1950's and 1960's. The projections for the city of Rochester indicate that population will fall by 13,200 persons between 1975-1985, but the (1985-2000) period will result in a 15,000 increase in population. The reason for the optimistic projection for this period is a matter of policy. It should be the concern of the county (as well as other levels of government) to assure the continued vitality of the

city of Rochester. The Monroe County Department of Planning feels that the adherence to this public policy and given effective public actions to carry it out, the city population can stabilize and begin to grow.

Although the population of Monroe County has been projected to grow very slowly, the rate of urban growth may outstrip population growth. Even with a stable population growth, there can be new housing, shopping centers, and manufacturing plants. This phenomenon occurred in Monroe County during the 1970-1977 period when the pace of urban growth outstripped the pace of population growth. For example, the population of towns in Monroe County increased by only 13 percent from 1970 to 1977, but the number of housing units increased by 25 percent. The reason for this was the decline in average household size during the 7-year period. In the future, urban growth may outpace population growth, but the low projections for the county suggest that the same fast pace of suburban development experienced during the period 1970-1977 cannot be expected.

Orleans County also has one of the highest growth rates for the Lake Ontario shoreline counties. One contributing factor to the growth in Orleans County is the Northwest Interceptor Sewer System. This system was designed to service Monroe County but will also service a portion of Orleans County. The development on the edge of the county will have a strong growth impetus on the rest of the county. Long-range transportation proposals affecting the county may result in increased in-migration from Rochester and Buffalo as worker access improves. Finally, as the corridors west of Rochester are developed, the large areas available for development in Orleans County will become increasingly attractive. The suburban development will be spurred by the development outside of Rochester. The suburban region surrounding Rochester developed due to adequate sewage and water treatment facilities. The villages of Honeoye Falls, Scottsville, Churchville, and Spencerport, suburbs of Rochester, have municipal sewerage systems. Only the development areas in southern Henrietta and northern Rush townships are without public sewers. The actual results of the population growth in Orleans County will depend on the planning policies of government officials and the land use controls implemented by local governments. The projections portray the basic patterns of development already in effect.

The overall growth rates for the 1970-2000 period for the city of Rochester, the county of Niagara, and Watertown were negative, indicative of declining economic growth within a region. Although the 1980-2000 population projections are optimistic for Rochester, the most likely trend is an overall decline in growth, due to suburban development. The other areas in Table 3.1 show slow to moderate growth rates. The major areas of development are in the eastern portion of Monroe County.

The urban sprawl in Orleans County is being discouraged by development policies oriented toward preservation of open space and more economical development of urban centers and facilities. The reason for the lower level of development, as compared to Monroe County, is the rural character of the county. In the 1960's, development might have been much greater had the county not lost its major employers. Most of the recent growth has been in

Table 3.1 - Population Projections

Area	1970	1975	1980	1985	1990	1995	2000
Cayuga County	77,439	77,998	79,077	80,336	81,683	82,354	82,964
Jefferson County	88,500	90,800	92,000	93,000	93,700	93,800	93,400
Watertown	30,800	29,100	29,900	29,800	29,400	28,900	28,100
Monroe County	711,900	708,600	714,100	731,700	767,400	811,500	853,400
Rochester, City	295,000	267,200	256,000	254,000	259,000	264,000	269,000
Niagara County	235,720	237,200	236,998	234,557	231,074	225,784	219,775
Orleans County	37,300	38,300	39,400	40,800	42,600	44,600	46,600
Albion, Town	6,600	7,100	7,100	7,300	7,600	8,000	8,300
Medina, Village	6,400	6,700	6,700	6,800	6,800	7,100	7,300
Oswego County	100,897	109,399	117,101	126,122	135,473	144,603	153,177
St. Lawrence County	112,300	117,100	119,500	122,700	125,300	126,600	127,100
Massena, Town	16,000	15,500	15,800	15,800	15,800	15,800	15,800
Ogdensburg	14,600	15,400	13,600	13,700	13,900	14,000	14,000
Wayne County	79,400	82,500	84,400	88,000	92,500	97,500	102,400
Newark, Village	11,600	10,700	11,400	11,900	12,100	12,400	12,700

Table 3.1 - Population Projections (Cont'd)

Area	2005	2010	2015	2020	2025	2030
Cayuga County	83,922	84,892	85,873	86,865	87,869	88,884
Jefferson County	93,000	92,600	92,200	91,800	91,400	91,000
Watertown	27,676	27,258	26,847	26,442	26,043	25,650
Monroe County	879,311	906,009	933,517	961,861	991,065	1,021,156
Rochester, City	264,941	260,943	257,005	253,127	249,307	245,545
Niagara County	217,568	215,384	213,222	211,081	208,962	206,864
Orleans County	48,254	49,967	51,741	53,577	55,479	57,448
Albion, Town	8,637	8,988	9,261	9,637	10,029	10,334
Medina, Village	7,447	7,597	7,750	7,906	8,065	8,228
Oswego County	161,868	173,520	186,011	199,401	213,755	229,143
St. Lawrence County	129,662	132,276	134,943	137,664	140,439	143,270
Massena, Town	15,800	15,800	15,800	15,800	15,800	15,800
Ogdensburg	14,000	14,000	14,000	14,000	14,000	14,000
Wayne County	107,092	112,000	117,132	122,500	128,113	133,983
Newark, Village	12,892	13,087	13,284	13,484	13,687	13,894

Source: NYS Economic Development Board, March 1979, Population by Counties

the towns adjacent to Monroe County rather than the urbanized areas of Albion, Holley, and Medina within the county itself. Since the 1970 Census, two manufacturing firms have located within the county, providing stabilization for the economy and encouragement for future development. Recent growth has been centered in the villages, where utility systems are readily available. The effect of this will likely be to attract people to the urbanized areas, reversing the trends of the 1960's.

3.2 INCOME

The income projections are based on the OBERS Projections Series of the U. S. Water Resources Council. The higher average per capita income in

Monroe, Orleans, and Wayne Counties is due to the direct influence of the Rochester SMSA. Monroe County has the highest income projections for the entire shoreline. The large per capita income may also be attributed to the large percentage of county residents in the labor force. The income projections for Cayuga, Jefferson, Oswego, and St. Lawrence Counties have lower per capita incomes. Although the seasonal residents have incomes in the higher brackets, the majority of residents in these counties are permanent residents. These individuals have considerably lower income levels than the seasonal dwellers. Niagara County, a region of declining growth, has higher income levels than the St. Lawrence River region, but they are considerably lower than the Rochester SMSA and its surrounding counties. The income projections for the Lake Ontario coastal counties are given in Table 3.2.

Table 3.2 - Income Projections

Area	1970	1980	1990	2000	2010	2020	2030
Cayuga County 1/	3,249	4,500	5,900	7,900	10,450	13,000	15,847
Jefferson County	2,779	4,000	5,200	7,100	9,550	12,000	15,361
Monroe County	3,990	5,512	7,072	9,360	12,168	14,976	18,256
Niagara County	3,472	4,800	6,200	8,200	10,850	13,500	16,456
Orleans County	3,837	5,300	6,800	9,000	11,700	14,400	17,554
Oswego County	3,249	4,500	5,900	7,900	10,450	13,000	15,847
St. Lawrence County	2,779	4,000	5,200	7,100	9,550	12,000	15,361
Wayne County	3,837	5,300	6.800	9,000	11,700	14,400	17,554
Rochester SMSA 2/	3,940	5,400	7,000	9,100	11,800	14,500	17,675

1/ Source: <u>OBERS Projections, Volume 3</u>, U. S. Water Resources Council, p. 94, 95, 96, 97.

2/ Source: <u>OBERS Projections, Volume 5</u>, U. S. Water Resources Council, p. 197.

Another interesting observation is that the Monroe County incomes are higher than those for the Rochester SMSA. The reason for this is probably due to a concentration of lower-income families in the city of Rochester. The median income for Monroe County was fourth highest among all the State's counties in 1969.

3.3 EMPLOYMENT PROJECTIONS

The growth in employment by county is based on the population forecasts. As the population grows, so will the available labor supply and those employed in the labor force. The employment projections are based on OBERS population-employment ratios for the period (1970-2030) shown in Table 3.3.

Employment projections are given in Table 3.4, and commercial employment projections are given in Table 3.5

Table 3.3 - Employment/Population Ratios

Area	1970	1980	1990	2000	2010	2020	2030
Cayuga County 1/	.38	.43	.44	.45	.45	.45	.45
Jefferson County	.34	.38	.39	.41	.41	.42	.42
Monroe County	.40	.45	.46	.47	.46	.46	.46
Niagara County	.38	.42	.43	.45	.45	.45	.45
Orleans County	.40	.45	.46	.47	.46	.46	.46
Oswego County	.38	.43	.44	.45	.45	.45	.45
St. Lawrence County	.34	.38	.39	.41	.41	.42	.42
Wayne County	.40	.45	.46	.47	.46	.46	.46
Rochester SMSA 2/	.41	.46	.46	.48	.46	.46	.46

1/ OBERS Projections, Volume 3, U. S. Water Resources Council, p. 94, 95, 96, 97.

2/ OBERS Projections, Volume 5, U. S. Water Resources Council, p. 197.

Table 3.4 - Employment Projections

Area	1980	1990	2000	2010	2020	2030
Cayuga County	34,000	35,940	37,330	38,200	39,090	40,000
Jefferson County	34,960	36,540	38,290	37,970	38,560	38,220
Watertown	11,360	11,470	11,520	11,180	10,960	10,630
Monroe County	321,350	353,000	401,100	416,760	442,460	469,730
Orleans County	18,120	19,600	21,900	22,990	24,650	26,430
Albion, Town	3,200	3,570	3,900	4,130	4,430	4,750
Medina, Village	3,020	3,130	3,430	3,500	3,640	3,790
Oswego County	50,350	59,610	68,930	78,080	89,730	103,110
St. Lawrence County	45,410	48,870	52,110	54,230	57,820	60,170
Massena, Town						
Ogdensburg						
Wayne County	37,980	42,550	48,130	51,520	56,350	61,630

Table 3.5 - Commercial Employment Projections

Area	1980	1990	2000	2010	2020	2030	Percent Employment 1/
Cayuga County	13,940	14,735	15,305	15,662	16,027	16,400	.41
Jefferson County	16,082	16,808	17,613	17,466	17,738	17,581	.46
Watertown	5,226	5,276	5,299	5,143	5,042	4,890	
Monroe County	138,181	151,790	172,473	179,207	190,258	201,984	.43
Orleans County	6,704	7,252	8,103	8,506	9,121	9,779	.37
Albion, Town	1,184	1,321	1,443	1,528	1,639	1,758	
Medina, Village	1,117	1,158	1,269	1,295	1,347	1,402	
Oswego County	21,651	25,632	29,640	33,574	38,584	44,337	.43
St. Lawrence County	23,613	25,412	27,097	28,200	30,066	31,288	.52
Wayne County	14,812	16,595	18,771	20,093	21,977	24,036	.39

1/ Source: Regional Employment by Industry, 1940-1970, U. S. Department of Commerce, Bureau of Economic Analysis, p. 25-31.

The employment opportunities in western Orleans County will not likely curb the growth in eastern Orleans County. The hope of private investors is that the industrial development will attract former commuters to Monroe County. Failure to develop a balanced economy in the county will result in losses to private investors and overutilization of existing sewer facilities in Orleans County. Employment in commercial activities would be centered around the residential development. The plan for commercial development is to provide services within and adjacent to villages. The recommended development for commercial is the individual store rather than the shopping center. The recent trend in Monroe County has been the concentration in the increasing portion of retailing services within planned shopping centers. The trend is expected to continue throughout the (1980-2030) period. This trend is accompanied by the decline in retailing within the city of Rochester and the village centers.

Wayne County, along the coastal areas, is limiting its plans for expected commercial development. The commercial development that does occur will provide employment opportunities in the commercial sector. In the town of Williamson, it has been recommended that commercial developments be limited to the type of activities which provides services to the local and transient population and recreation-related services. The town of

Sodus/South Shore Geographic Area of Particular Concern (GAPC) should provide recreation-related commercial development oriented to marine activity. Development in this area should be limited. The town of Huron/Sodus Creek GAPC has been slated for general commercial use as well as public or private recreation-related commercial use. The East Bay Park GAPC and Long Point GAPC have also been recommended as appropriate sites for recreation and service-related commercial uses.

The nature of commercial employment in the St. Lawrence-Eastern Ontario Commission region is varied. The four counties in which the Commission's service lies are Cayuga, Oswego, Jefferson, and St. Lawrence. The employees are either permanent, seasonal, or transient. Approximately 38.1 percent of the permanent labor force is employed by the commercial sector. The area is a primary recreational site as well. Thus, there is a significant commercial employment in the seasonal and transient groups. Out-migration is occurring among young, talented labor due to a stagnant economy. There are three predominant occupational groups for this region of the Lake Ontario shoreline counties including: (1) professionals, (2) retirees, and (3) craftsmen. Retirees constitute the largest permanent resident occupational class due to the low cost of living in the area and the fact that in many cases their families have lived in the area for years.

Industrial employment projections were not developed for the project since the shoreline, other than the Rochester SMSA, is highly undeveloped.

3.4 HOUSING PROJECTIONS

The housing projections in Table 3.6 are based on the population projection series. The density ratios are based on the 1970 Housing Census of the Department of Commerce. The growth in population will have to be accommodated by a corresponding increase in housing.

Table 3.6 - Housing Projections

Area	1980	1990	2000	2010	2020	2030
Niagara County	404	-	-	-	-	-
Orleans County	727	1,107	1,384	1,165	1,249	1,339
Albion, Town	167	167	233	229	216	232
Medina, Village	106	35	177	105	110	114
Monroe County	707	17,138	27,653	16,916	17,959	19,066
Wayne County	1,656	2,682	3,278	3,179	3,477	3,802
Newark, Village	-	263	226	145	149	154
Cayuga County	557	886	436	656	671	687
Oswego County	9,476	10,744	10,353	11,896	15,135	17,393
Jefferson County	1,373	667	-	-	-	-
St. Lawrence County	2,353	1,895	588	1,692	1,761	1,832

Monroe County, since 1970, has had 67 percent development in multi-family unit construction. The development of high-density housing is nothing to be alarmed at. It uses less land than single-family homes and the multi-family units are also more efficient to heat, thereby reducing energy consumption. There are also exciting possibilities in the design of multi-family units. Coastal areas of Greece and Irondequoit are largely developed and are experiencing pressures for additional development. The development of rural coastal towns has occurred due to their aesthetic and recreational assets. These assets have attracted residents of Monroe County to the coast to build new homes and to renovate summer homes for year-round use.

Throughout the city of Rochester, the trend in housing is the construction of high-density to medium-density housing. An example of the high-density housing proposal sites is the Hastings Street Development. Although the area overlooking Lower Falls is small, there are proposals to construct medium-rise housing at the bottom of Hastings Street and high-density housing at the top of the bank. Along the coastal shoreline of Wayne County, residential development is recommended in areas which have adequate water and sewer facilities. Both permanent and seasonal residential housing is planned for the coastal region. In areas with inadequate facilities, large lot residential zoning is encouraged. This would enable the proper use of septic tank systems.

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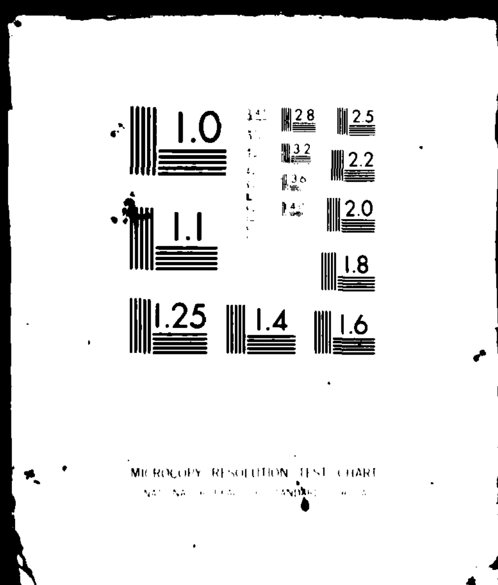

In Orleans County, potential development exists in areas adjacent to existing urban centers, particularly in the town of Albion and the village of Medina. The county of Orleans has generally low density housing. The housing projections are based on the entire county, rather than the coastal zone. In order to develop as a desirable community, Orleans County will have to upgrade neighborhood appearances and community facilities. In order to provide adequate and proper housing, enforcement of adopted subdivision regulations must be undertaken and adoption of revised zoning ordinances must take place to assure developing the desirable range of housing types, and provision of adequate utilities and facilities to support new housing communities. The 1975 Comprehensive Development Plan of Orleans County designates the towns of Carlton and Yates as suitable for "low-intensity development." These towns have also been zoned as "river and creek" residential districts.

Unlike the other coastal counties, the St. Lawrence River area is primarily leisure homes. The counties of Cayuga, Oswego, Jefferson, and St. Lawrence are in the vacation area. The Thousand Islands are popular for leisure home development because of their scenic beauty and ideal boating location. This area, in particular, lends itself to waterfront development. The county of St. Lawrence has a relatively high density (3.06). In the coastal zone region, the average household size is 4.19. This is due to the vacation, leisurely-like atmosphere of this region. Both seasonal and permanent residential housing units will be constructed in the county. Although there have been no projections made for Jefferson County, there will likely be seasonal dwellings built along the shoreline with densities ranging between 2.5 to 33.3 acres per unit. Both the Jefferson County Land Use Plan and the St. Lawrence Regional Land Use Plan (1977) allow for seasonal dwelling development. The town of Henderson, along the shoreline, has been slated for summer cottage construction. Cayuga and Oswego County housing projections are based on the needs of future area growth.

3.5 LAND USE

Our generation is characterized by change including increasing population, rapid urbanization, increasing productivity and affluence, and technological advances. In order to meet the pressures of a growing society, there will be an increased use of land in various activities. For this study, residential, commercial, industrial, and recreational land uses in the coastal counties are expected to increase.

3.5.1 RESIDENTIAL

The future housing units required to accommodate increased population in the coastal counties are shown in Table 3.7. The persons per dwelling unit is used to determine the number of housing units required. The acreage requirement per unit dwelling is .33 acres/unit for Cayuga, St. Lawrence, Oswego, Orleans, and Wayne Counties. Monroe County has a different acres/unit requirement due to the recent trend of high-density housing within the county. The projected land use for the village of Newark, Wayne County, the town of Albion, Orleans County, and the village of Medina, Orleans County,

were also determined. The total acreage for residential housing requirements is 62,498 acres for the coastal counties for the (1980-2030) period. The acreage requirement per dwelling unit is assumed to remain constant throughout the period (1980-2030).

Table 3.7 - Projected Residential Land Use

Year	Required Housing Units	Acres/Unit	Acres
	Orleans County		
1980	727	.33	240
1990	1,107	.33	365
2000	1,384	.33	457
2010	1,165	.33	384
2020	1,249	.33	412
2030	1,339	.33	442
	Town of Albion		
1980	167	.33	55
1990	167	.33	55
2000	233	.33	77
2010	229	.33	76
2020	216	.33	71
2030	232	.33	77
	Village of Medina		
1980	106	.33	35
1990	35	.33	12
2000	177	.33	58
2010	105	.33	35
2020	110	.33	36
2030	114	.33	38

Table 3.7 - Projected Residential Land Use (Cont'd)

Year	Required Housing Units	Acres/Unit	Acres
	Monroe County		
1980	707	.25	177
1990	17,138	.25	4,285
2000	27,653	.25	6,913
2010	16,916	.25	4,229
2020	17,959	.25	4,490
2030	19,066	.25	4,767
	Wayne County		
1980	1,656	.33	546
1990	2,682	.33	885
2000	3,278	.33	1,082
2010	3,179	.33	1,049
2020	3,477	.33	1,147
2030	3,802	.33	1,255
	Village of Newark		
1980	-	-	-
1990	263	.33	87
2000	226	.33	75
2010	145	.33	48
2020	149	.33	49
2030	154	.33	51

Table 3.7 - Projected Residential Land Use (Cont'd)

Year	Required Housing Units	Acres/Unit	Acres
	Cayuga County		
1980	557	.33	184
1990	886	.33	292
2000	436	.33	144
2010	656	.33	216
2020	671	.33	221
2030	687	.33	227
	St. Lawrence County		
1980	2,353	.33	776
1990	1,895	.33	625
2000	588	.33	194
2010	1,692	.33	558
2020	1,761	.33	581
2030	1,832	.33	605
	Oswego County		
1980	9,476	.33	3,127
1990	10,744	.33	3,546
2000	10,353	.33	3,416
2010	11,896	.33	3,926
2020	15,135	.33	4,995
2030	17,393	.33	5,740

3.5.2 COMMERCIAL

The increased land use necessary to support the larger population is based on employees/acre by decade. The acres/employee are .032 based on density numbers derived in the Erie County Land Use Plan (1971). This is a conservative land use estimate. The total projected commercial land use in acres for Orleans, Oswego, St. Lawrence, Wayne, Cayuga, and Monroe Counties is 3,484 acres as shown on Table 3.8. The shoreline commercial development will be limited to service-oriented and recreational-oriented commercial activities. Major retailing centers or strip commercial development is expected to occur in Monroe County which has the heaviest acreage requirement for commercial activities. Commercial development in Monroe County has been following certain patterns in recent years. An increasing number of retailing and services are being concentrated in planned shopping centers. This trend is expected to continue until 2030 when the population reaches 1,000,000.

There is also a trend to locate commercial development in strips along major highways. For example, East Ridge Road and West Henrietta Road in Monroe County suffer from strip commercial development. Another trend in commercial development is the decline in retailing within the city of Rochester and the village centers. Also, there is a movement away from neighborhood shopping facilities towards major regional facilities. This trend has been attributed to changing settlement patterns and land use regulations. Zoning regulations in suburban areas have prevented such facilities from being built in locations accessible to residential development.

Table 3.8 - Projected Commercial Land Use

Year	Commercial Employees	Acres
	Orleans County	
1990	548	18
2000	851	27
2010	403	13
2020	615	20
2030	658	21
	Oswego County	
1990	3,981	127
2000	4,008	128
2010	3,934	126
2020	5,010	160
2030	5,753	184
	St. Lawrence County	
1990	1,799	58
2000	1,685	54
2010	1,103	35
2020	1,866	60
2030	1,222	39
	Wayne County	
1990	1,783	57
2000	2,176	70
2010	1,322	42
2020	1,884	60
2030	2,059	66

Table 3.8 - Projected Commercial Land Use (Cont'd)

Year	Commercial Employees	Acres
	Cayuga County	
1990	795	25
2000	570	18
2010	357	11
2020	365	12
2030	373	12
	Monroe County	
1990	13,609	435
2000	20,683	662
2010	6,734	215
2020	11,051	354
2030	11,726	375

3.5.3 INDUSTRIAL

The Rochester SMSA is the center of industrial production within the study area. According to the Coastal Zone Management Program, the Port of Rochester is zoned for industrial land use. There has been an effort by local and county officials to keep industrial development within the city limits rather than encourage suburban expansion. Nonetheless, the majority (if not all) industrial employment is expected to occur outside the city. Port-related industry, commerce, and warehousing are present land use activities at the site. The Port of Rochester may be developed as a more commercial-oriented area in the future. The port authority area is the proposed site for a commercial marina. The site could also provide a boat launching ramp with adjacent parking. Rather than the present M-1 classification for zoning, it has been suggested that the new zoning ordinances classify it C-3 which could allow for a variety of consumer service establishments. Orleans County will have some industrial development in the eastern portion of the county due to the influence of the Monroe County, Rochester SMSA, growth spurt. Recent developments of manufacturing plants in the western portion of the county should also encourage industrial development.

3.6 RECREATIONAL AND OPEN SPACE

3.6.1 FUTURE FACILITIES

The coastal zone region is an ideal location for several recreational activities. Areas designated as open space which should remain as such are those areas not suitable for development. Wetlands, flood hazard areas, areas subject to ponding, areas where bedrock is close to the surface, and areas of highly erosive soils should be preserved.

There are several plans for development of recreational sites and facilities along the Lake Ontario shoreline. In Niagara County, a recreational site is proposed for development along Eighteenmile Creek. The 70-acre area is recommended for a natural wildlife preserve. Johnson Creek, in Orleans County, has been proposed as a possible small harbor boat site. The Eagle Cliffs area is also an appropriate recreational site because it is also slated for intensive future development. The proposed sites along the shoreline which have been recommended for recreational development are shown in Table 3.9.

Table 3.9 - Proposed Recreational Facilities

County	Location	Type	Activities
Niagara	Eighteenmile Creek	wildlife preserve	hiking, scenic view
Orleans	Johnson Creek, mouth	small-boat harbor	boating, fishing
Wayne	Eagle Cliffs, Town of Ontario	county park	intensive uses
Wayne	South Shore, Town of Sodus	state park	intensive uses
	Sodus Bay		
Monroe	Town of Hamlin	Hamlin Beach State Park expansion	camping, beaching activities, boating, fishing, picnicking, bicycling, golfing, playgrounds
Monroe	Town of Greece	Braddock Bay State Park expansion	marina, bathing beaches, golfing, boating

Source: <u>New York State Coastal Management Program, Volumes I & II</u>, New York State Department of State, March 1979.

3.6.2 MULTI-PURPOSE USE POTENTIALS

Some public and quasi-public facilities have potential for future recreational development as indicated on Table 3.10. A number of water-oriented and water-enhanced recreation activities can be developed at power plant sites, including boat access sites and marinas, fishing access sites, picnic areas, and scenic overlooks. There is a new requirement of the Federal Energy Regulatory Commission which requires any projects which will generate 2,000 horsepower and above to include a supplemental plan which outlines the company's plan for recreational development. This policy has opened up many power plant sites for recreational use. There are negative factors involved with the development of power plants as recreational sites. Generally, plants are located in heavily industrialized areas. The physical features of the plant cause aesthetic blight, and the air and water pollution lower the quality of the recreational experience.

Careful planning and management can overcome these negative aspects in the use of power plant sites.

Utility, pipeline, powerline and railroad rights-of-way have significant potential for multi-purpose use, including hiking, biking, cross-country skiing, snowshoeing, horseback riding, and nature appreciation. The Department of Transportation has acquisition powers which can be used to promote these multi-purpose uses. The Department has the power to acquire "multi-use areas" adjacent to highway facilities.

Reservoirs may also be used as potential recreational sites. Water dependent recreation activities such as fishing and boating and other related activities such as walking, picnicking, camping, hiking, and cross-country skiing may be developed at reservoirs.

Until very recently, sewage treatment plants were not considered potential recreational sites. The Clean Water Act of 1977 states that grants for treatment works depend on "the applicant analyzing potential recreation and open space opportunities in the planning of the proposed treatment works." 1/ Due to advances in modern technology, the sewage treatment sites may provide access points for boating and fishing, hiking and biking trails, pumpout stations for boats and recreational vehicles, picnicking, and site-seeing.

Some of the agricultural land along the shoreline also has potential for recreational development. These are the areas where there are high bluffs above narrow beaches making agricultural uses minimal. These lands could be used in the following recreational activities: hiking, camping, picnicking, and physical and visual access to the coast. Agricultural lands adjacent to

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1/ Public Access and Recreation Within the Coastal Boundaries of New York State, NYS Office of Parks and Recreation, March 1978, p. 2)

Table 3.10 - Multi-Purpose Potentials

Project Type	Potential Recreational Activities	Considerations
Sewa Treatment Plants	Access points for boating and fishing, parking for facilities, hiking and biking trails, pumpout stations for boats and recreational vehicles, limited picnicking	Size and location of plant accessibility to water and trails, water quality of receiving waters, existing access facilities.
Highways	Bike trail	Width of road, amount of traffic, safety aspects.
Reservoirs (Hydroelectric)	Camping, fishing, boating, hiking, biking, picnicking, hunting, cross county skiing, snowshoeing, snowmobiling, nature study.	Water level fluctuations, water quality, intake structures.
Water Supply Reservoirs	Fishing, boating, swimming, hiking, picnicking, biking, camping, court and field games, hunting, riding, golf, cross country skiing, snowshoeing, snowmobiling, ice skating, nature and environmental programs.	Size of reservoirs, level of treatment, community preferences, compatibility of activities, site characteristics, opportunities available at nearby sites, existing laws and regulations, demand for activities.
Transmission Lines	Hiking, biking, horse riding	Terrain, voltage of line, liability, structural hazards.
Main Sewer Lines	Hiking and biking trails	Topography, surrounding area.
Solid Waste Disposal Sites	Field games, court games, swimming pools	Health factors, gas releases, soil conditions, settlement, type of fill material.
Agricultural Land	Hunting, fishing, hiking trails, bird watching, nature study, snowmobiling, cross country skiing, snowshoeing	Type of crop, livestock, fence type and extent, active working areas, structures, liability.

Source: New York State Comprehensive Recreation Plan, New York State Office of Parks and Recreation, 1978.

bays and rivers may also be future potential areas for recreational activities.

A number of utility companies have included the development of recreational facilities and the protection and restoration of scenic areas in their planning programs. Two examples of the incorporation of recreation and conservation into power projects are the St. Lawrence Project and the Niagara Project.

The major constraints to the use of public and quasi-public facilities for recreational sites are water supply properties due to health considerations and questions of liability. The concept of multi-purpose use will continue to grow in importance, particularly as recreational land, and open space become scarce and new pollution control acts are passed to assure quality recreational experiences.

3.6.3 COASTAL TRAILS

Another potential development feature which would enhance the recreational experience is the establishment of a coastal trails system. The intent of the coastal recreationway program is to provide people with automobile and walking access to areas along the coastline. The system should also integrate the existing infrastructure of urban areas, parks, parkways, trails, waterways, historic sites, wetlands, wildlife and forest areas, and other open space preserves into an interconnected system. The recreational activities to be provided for are hiking, bicycling, cross country skiing, horseback riding, and in some cases, boating, fishing, camping, picnicking, and scenic appreciation. The Monroe County Legislature is planning to claim the right-of-way of the abandoned Hojack Line for the development of recreational trailways along the entire coastal zone shoreline. In summary, a coastal recreationway would provide a unique recreational experience and equally important, it would link parks, historic sites, and scenic and natural areas along the State's coastline.

3.7 AGRICULTURE

The loss of farmland to more intensive development remains a problem, but the rate of loss of farmland has slowed somewhat. The loss of farmland within coastal counties declined 2.3 percent between 1969 and 1974. The Coastal Zone Management Program is concerned about the preservation of prime agricultural land. Proposed methods for the preservation of agricultural land are zoning ordinances, and transfer of development rights. The rural zoning ordinances, where tried, have been upheld by the court. In rural communities, agricultural activities are permitted in all areas zoned for large lot residential use. Another method for the preservation of agricultural land is the encouragement of the acquisition of public land for future development. The problem with this method is the need for substantial public funds.

3.8 PUBLIC AND OTHER

Any new energy facilities will represent a drain on the coastal land area. Coastal water locations will be necessary for the following reasons: for cooling purposes in steam-electric generating facilities; for the production, transfer, or transportation of raw or processed energy resources, and, potentially for the economical production of electricity through the harnessing of wave and tidal actions. A proposed future facility is the 1,300 MW nuclear fuel steam electric generating plant with a natural draft cooling tower at Nine Mile Point by May 1995.

Another concern of the coastal zone region is the water supply. In spite of the availability of many freshwater lakes, rivers, and streams, there is still predicted to be major shortages by the year 2000.

In order to maintain acceptable water quality standards throughout the coastal zone region, it is essential to provide adequate sewer and water treatment facilities. The State Pollutant Discharge Elimination System (SPDES) conforms to the high standards set forth in the Federal Water Pollution Control Act Amendments of 1972. Urban land use or intensive development should only occur in areas which have adequate water and sewage treatment facilities. Throughout the coastal zone, land use plans recommend intensive residential and commercial development in areas with proper facilities.

The Monroe County Water Authority has a direct influence on the expansion of water supply to newly developed areas. They may approve or disapprove "tie-ins" to the water distribution system.

The sewage treatment plants and outfalls are only servicing the city of Rochester and the towns of Greece and Irondequoit. The Monroe County Pure Waters Agency is presently involved in a program to provide sewer service to much of the coastal area. In order to make the provision of sewage treatment services economically feasible, conditions of overcrowding would be likely to occur. This would have an adverse impact on the aesthetic and natural resource attraction of the areas, but the continuation of the use of the septic tank system will result in degrading the water quality which attracts people to the area.

3.9 FISH AND WILDLIFE RESOURCES

3.9.1 HABITAT

It is expected that wildlife resources of the Lake Ontario drainage basin will be subjected to increased adverse impacts in the future. The single most important basin-wide problem is the loss of habitat. A total of 5,099,000 acres in the Great Lakes Basin is expected to be lost in the 50-year period 1970-2020. (GLBC 1975 App. 17)

The single, most important factor affecting wildlife resources and their habitats is human population growth and the resultant increase in land use intensity. Population increases will cause losses of wildlife habitat through the various activities that demand land-road construction, agriculture, housing developments, industrial parks, recreational areas, etc. Degradation of the quality of habitat will also occur as a result of human habitation and activities, but these effects may be less conspicuous. (USCOE 1979)

Destruction of shoreline marshes increases during periods of lower lake levels. At such times, the dry marshes are more easily accessible and are used for solid waste dumping. The present earth moving equipment can destroy a marsh in a relatively short time. Records of permits issued in the last 10 years indicate marsh destruction occurring at a rate of several hundred acres annually. These figures are minimal since marshlands adjacent to, but not abutting on the shoreline, can be filled or destroyed without a permit. It is anticipated that, should this type of marsh despoilation continue, 10,000 acres or more will be lost during the next 50 years. (IGLLB 1973).

Both warmwater and coldwater species use shallow littoral zones, shoals, and wetland areas connected to Lake Ontario and the St. Lawrence River for spawning and nursery habitat. Since these areas are particularly vulnerable to encroachment by development, the spawning suitability of these areas has been decreasing rapidly. This has been due in part to the dredging, draining, and filling of wetland areas, dredging of bays and inlets, and construction activities. (SLEOC 1978)

Secondary effects of land use changes include the intensification of agricultural activity on presently cultivated lands. Agricultural land is important wildlife habitat, but as more clean farming is instituted, the wildlife value of agricultural land diminishes. The resulting fewer acres of idle land, woodland, fence rows, and field borders support less wildlife. (GLBC 1975 App. 17)

Some of the most exceptional farmlands in the state are found along the south shore of Lake Ontario. However, the valuable orchard and vegetable lands are being transformed due to:

a. Suburban spread is taking more and more farmland.

b. Expressway extension is taking more and more farmland.

c. Farms are being turned into rural nonfarm uses, and summer cottages are being turned into year round homes. (Genesee Finger Lakes Regional Planning Board 1971)

And, despite State efforts to stem the loss of the nation's agricultural land, farmland continues to disappear at a rate of nearly three million acres a year, according to a report released in May by the President's Council on Environmental Quality (CEQ) (IJC 1979).

It has been pointed out that future management of wildlife resources must center on (1) more even distribution of preserved or restored wetlands and feeding areas including agricultural areas and (2) maintaining water levels in marshes bordering Lake Ontario and other waters serving multiple use purposes. (Carlson 1973)

3.9.2 FISHERIES

The future fisheries of Lake Ontario will continue to change from that which now exists. The degree and nature of change will depend upon fishery management efforts undertaken. The State of New York expects to continue to develop and maintain one of the finest salmonid fisheries in the country, in combination with an excellent warm water fishery in the lake (Ontario) and the St. Lawrence River. (USCOE 1979)

Accordingly, the Fish and Wildlife Services assessment of projected Lake Ontario fisheries (without-the-project) is based on certain key premises. (USCOE 1979)

It is assumed that, overall, the quality of Lake Ontario waters will not become degraded or deteriorate beyond existing conditions. The Federal Government's mandate to clean up the nation's waters is expected to provide the impetus and necessary safeguards to protect water quality, while New York State's pure waters and environmental protection programs will ensure protection of the Lake Ontario resource base. Shoreline development by individuals, industrial interests, and commercial enterprises may tend to negate to some extent the promise of a high quality aquatic environment. It is expected, however, that future developments will be implemented in a more environmentally sound manner than most prior developments. It is reasoned that dredge and fill activities along shorelines and tributary streams, in addition to point source effluent discharges, will be subject to more stringent requirements and regulations than are now demanded. For fish and wildlife planning purposes, it is foreseen that Lake Ontario waters will at least maintain their present level of quality.

The rapidly developing sport fishery for salmon and trout in portions of Lake Ontario is expected to continue its present trend. The Sea Lamprey Control Program, which has been cooperatively carried out on the Great Lakes for about three decades by the United States and Canadian Governments, is now paying dividends. Sea lamprey populations have been reduced and there has been a dramatic decrease in lamprey predation on lake trout, salmon, and steelhead. Lake trout populations are expected to rebound due to the control efforts and important ongoing lake trout restocking programs. The Fish and Wildlife Service envisions the continuation of lamprey control activities and the lake trout plantings in Lake Ontario.

Coho and chinook salmon plantings in Lake Ontario are primarily due to the efforts of the State of New York. It has rejuvenated sport fishing in the lake and on certain tributary streams. The future for coho and chinook salmon in Lake Ontario appears to be promising. Again, an assumption has been made that these salmon fisheries will be perpetuated and allowed to

expand through stocking and management by the State of New York in order to satisfy sport fishing demands of present and future anglers.

With the continuation of the Sea Lamprey Control Program, lake trout planting, and the regular stocking of salmon, Lake Ontario has the potential of providing outstanding sport fishing for many hundreds of thousands of anglers annually. The prospects for a large resurgence of commercial fishing is conjectural. In brief, the future Lake Ontario sport fishery, without the winter navigation season extension, can be expected to be improved and more heavily utilized by fishermen than the existing fishery. The traditional and newly developed ice fishing areas would maintain their popularity and continue to provide fishing opportunities.

3.9.3 RESOURCE USE

In nearly all of the Great Lakes planning areas, the demands for consumptive and nonconsumptive uses are projected to be at least double the current demand and in many areas three or four times the current demand. (Carlson 1973) Nonconsumptive wildlife use (nonhunters) is expected to exceed consumptive use (USCOE 1979); and, as user pressures increase, the user policies will probably change by implementing more nonconsumptive uses and by planning for a wider scope of uses and intensity of uses. (Carlson 1973)

a. Commercial Fishing

With regard to commercial fisheries, historically, Lake Ontario has been the lowest producer of commercial fish products of all the Great Lakes, and the U.S. portion of the catch from Lake Ontario makes up a small portion of the total catch. The projected demand to 2020 for the Great Lakes is expected to increase four-fold from the past 100 million-pound production of the five lakes. Demand on the Lake Ontario commercial fishery is expected to parallel the overall Great Lakes pattern. While many tributaries of Lake Ontario are not fished commercially, they do supply spawning areas for important commercial and sport fish. (U.S. Fish and Wildlife Service 1969)

b. Wildlife and Recreation

Presently, much of the public and private marshlands are for hunting and wildlife viewing. These recreational opportunities will decrease as expanded urbanization tends to degrade and destroy the wildlife environment. The value of shoreline habitat will increase rapidly and man will be willing to pay more for the privilege of hunting and pursuing other forms of wetland oriented outdoor recreation. Unless there is an all-out effort undertaken by public and private agencies to protect and enhance the existing marsh and wetland ecosystems in consonance with other uses, this environment and the associated recreation uses will steadily deteriorate. Solutions to maintenance of the present shoreline marshes may have to be accomplished through legislative means. Wetland offer the greatest potential for management. Public acquisition in the absence of intensive management will never maintain environmental quality for wildlife. (IGLLB 1973)

Wildlife resources in the Lake Ontario drainage basin will continue to provide outdoor opportunities for hunting, birdwatching, photography and other related activities; however, the quality of the experience is expected to decline due to more crowding and competition from participants. (USCOE 1979)

Estimates of annual hunter use in the Lake Ontario Basin by the year 2020 approaches 4.6 million hunter days. (U.S. Fish and Wildlife Service 1969) In the St. Lawrence River Basin, in 1970, 35,000 hunters were active. This number is expected to increase to 41,000 by 1980. It is also estimated that by 1980, 28,000 acres of wildlife habitat will be needed to satisfy the demands of hunters in the St. Lawrence River Basin. (USCOE 1979)

Fishing throughout New York State is expected to experience growth in total demand throughout the year 2000. (NYS Office of Parks and Recreation 1972) The 1978 Statewide Comprehensive Recreation Plan states that management of sport fishing opportunities should continue as a component of environmental preservation efforts. As one part of that effort, DEC has the responsibility of expanding the salmonid fisheries program in Lake Ontario. In 1960 sportfishing pressure for the Lake Ontario Basin was estimated at 3.2 million angler days. This use is expected to double by the year 2020. (SLEOC 1978, U.S. Fish and Wildlife 1969)

Pleasure boating is a substantial and growing use in all areas of New York's coastal zone, especially as it relates to an expanding fisheries program. (NYSDEC 1977)

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SECTION 4
PROBLEMS, NEEDS AND CONCERNS

LAKE ONTARIO SHORELINE PROTECTION STUDY

SECTION 4

PROBLEMS, NEEDS AND CONCERNS

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FIGURES

SECTION 4 - PROBLEMS, NEEDS AND CONCERNS

During Stage 1, the major emphasis of study efforts was placed on the identification of problems, needs, and opportunities associated with the water and related resources of the U.S. shoreline of Lake Ontario. (See the discussion of tasks in Section 1.5.1.) The identification of problems and needs consists of analyzing existing and future conditions, as identified in Sections 2 and 3, previous studies along the shoreline, the concerns of the public, and previously identified resource management problems. This analysis is guided by the national policy for water resource planning. This policy states that Federal and Federally assisted water and land resource management activities be planned toward achieving National Economic Development (NED) and Environmental Quality (EQ).

4.1 NATIONAL OBJECTIVES

The overall purpose of water and land resource planning and development is the promotion of the quality of life. This is done by reflecting societal preferences. Through many and varied laws and actions, the Congress and the President have defined the objectives or goals which guide water and land resource planning. These goals are defined by the Principles and Standards for Planning Water and Related Land Resource (P&S), which were established by the Water Resources Council. It reflects national priorities for management of the nation's water and land resources by providing that the planning for their development and management be accomplished by enhancing two co-equal goals or objectives. The first is National Economic Development (NED) which promotes the quality of life by increasing the value of the Nation's output of goods and services, and improving national economic efficiency. In regards to this study, a reduction of damages due to erosion and flooding would improve economic efficiency. The second goal or objective is Environmental Quality (EQ) which promotes the quality of life by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. These two goals serve to guide the entire planning process; therefore, the identification of problems, needs and opportunities, as well as the formulation of plans and the evaluation of their impacts must be done with full recognition to attaining national economic development and environmental quality.

4.2 PREVIOUS STUDIES

Previous studies of the Lake Ontario shoreline have been reviewed with a view to determining previously-identified problems and needs. The studies discussed here relate to erosion and flooding, the main impetus for the study. A discussion of recreational navigation and other related studies is found in Section 1.4.

4.2.1 BEACH EROSION CONTROL

a. Beach Erosion Control Study of New York State Parks on Lake Ontario - This cooperative beach erosion control study was initiated by formal application from the Division of Parks, Conservation Department, State of New York, dated 28 January 1953 and approved 1 March 1953 by the Chief of Engineers

under authority conferred by Section 2 of the River and Harbor Act of 3 July 1930, as amended and supplemented.

The purpose of this overall study was to develop the most suitable plans for the protection of the shores of four established State parks known as Selkirk Shores State Park, Fair Haven Beach State Park, Hamlin Beach State Park, and a State-owned area surrounding Braddock Bay, with a view to preventing further erosion of the shores within these areas and to determine the extent of Federal participation in the cost of a project for beach erosion control. The plans were to include protection of specific areas within each park by the restoration or creation of beaches.

It was determined that in order to facilitate action thereon by State and Federal agencies, separate reports were to be submitted for each study.

(1) Beach Erosion Control Report on the Cooperative Study of the New York State Parks; Lake Ontario - Selkirk Shores State Park - 30 June 1953. The purpose of this beach erosion control study was to develop the most suitable plans for the protection of Selkirk Shores State Park by restoring certain bathing beaches for the dual purpose of shore protection and recreational use and protecting the remainder of the shore by the most economical means.

The recommended plan of improvement consisted of the construction of an outlet structure at Grindstone Creek, restoration and protection of approximately 900 feet of beach north of the creek by direct placement of sand and gravel fill, alteration of an existing groin and construction of a new groin. The plan also provided for the construction of approximately 4,400 feet of stone revetment northerly of the beach area.

The project was authorized by the 1954 River and Harbor Act. The uncompleted portion of the project is classified as deferred for restudy due to lack of local interest.

(2) Beach Erosion Control Report on the Cooperative Study of the New York State Parks; Lake Ontario - Fair Haven State Park - 1 February 1954. The purpose of this beach erosion control study was to develop the most suitable plan for the protection and improvement of the Lake Ontario shore of Fair Haven Beach State Park.

The report recommended Federal involvement in the restoration, protection and improvement of a proposed bathing beach near the westerly limit of the park. The work was to consist of the modification of an existing groin, modification of the Sterling Creek outlet structures which crossed the beach areas, construction of a new groin, and placement of sand fill. The report also recommended that New York State consider adopting the Corps plans of improvement for the intervening bluff area and the easterly beach area.

The westerly beach project was authorized by the 1958 River and Harbor Act. The project is now classified as deferred for restudy due to lack of local interest.

(3) Beach Erosion Control Report on the Cooperative Study of the New York State Parks; Lake Ontario - Hamlin Beach State Park - 6 July 1954. The purpose of this beach erosion study was to develop the most suitable plan for the protection and improvement of the Lake Ontario shore of Hamlin Beach State Park.

The report recommended Federal involvement in the improvement of the westerly beach area. The work was to consist of the construction of six new groins, alteration of an existing groin, construction of a new outlet structure to control the level of a nearby pond and beach replenishment along 4,250 feet of park shoreline. The report also recommended that New York State consider adopting the Corps plans of improvement for the central and easterly beach areas.

The westerly beach project was authorized by the 1958 River and Harbor Act, and was completed in 1975.

(4) Beach Erosion Control Report on the Cooperative Study of the New York State Parks; Lake Ontario - Braddock Bay State Park - 1 October 1954. The purpose of this beach erosion control study was to develop the most suitable plan for the protection and improvement of the Lake Ontario Shore of Braddock Bay State Park. Only those features of the overall State plan related to the restoration, improvement and creation of the beach area were considered in the report. A plan of improvement was developed; however, no economic analysis of project justification was made as the State had no immediate plans for development at the time. Accordingly, the Corps of Engineers recommended that no project be adopted by the United States at that time.

b. Beach Erosion Control Study of the South Shore of Lake Ontario - Separate resolutions requesting studies of beach erosion control and related purposes at Fort Niagara State Park, Golden Hill State Park, and Fourmile Creek State Park were adopted by the Committee on Public Works of the House of Representatives on 14 April 1964. The three studies were combined by the Chief of Engineers into a single study of the south shore of Lake Ontario. Separate interim reports were to be submitted for each study.

(1) Beach Erosion Control Study of the South Shore of Lake Ontario - Interim Report on Fort Niagara State Park - January 1968. The purpose of this study was to develop a plan of improvement to provide erosion control, a public bathing beach, and to determine the justification for, and the extent of Federal participation in the cost of the considered improvements.

The study found the most suitable plan of improvement to be replenishment and improvement of the beach by placement of sand fill, and protection of the fill and existing shore by construction of a low offshore breakwater generally parallel to the shore.

A project was authorized under provisions of Section 201, 1965 Flood Control Act, but was classified as inactive due to water pollution problems at the park. By letter dated 6 May 1980, NYS Office of Parks and Recreation (OPR) indicated that the water quality ". . . has improved considerably and that it is no longer an important constraint to use of the beach for

swimming . . ." Based upon the favorable reports on water quality and the high demand for swimming at the beach, OPR felt it appropriate that the study be reactivated. By letter of 13 May 1980, OPR was requested to reaffirm the items of local cooperation. To date, no reply has been received and the study remains inactive.

(2) South Shore of Lake Ontario - Interim Report on Golden Hill State Park, New York; Phase I - May 1968. The purpose of this study was to determine the advisability of making a detailed investigation of developing a small-boat harbor at Golden Hill State Park, of protecting the park's lake frontage from erosion, and of improving a recreational bathing beach.

The study concluded that improvements for small-boat navigation and beach expansion and protection were sufficiently feasible to justify further studies.

A Phase II Study of Golden Hill State Park was started, but never completed due to its low priority ranking by New York State.

(3) Final Report on the South Shore of Lake Ontario and Report on Fourmile Creek State Park, New York; Phase I - February 1969. The purpose of this study was to determine the advisability of making a more detailed study of the construction of a small-boat harbor at Fourmile Creek State Park and the improvement of the park's lake frontage to provide erosion protection and a recreational bathing beach.

It was concluded in this report that improvements for small-boat navigation and the recreational beach were justified and that the shore protection works were not. Recommendations called for a survey report to be prepared to further investigate the justification of Federal participation in the improvements for small-boat navigation and recreational bathing at Fourmile Creek State Park.

This project is presently classified as deferred due to its low priority rating by New York State.

c. Niagara County, New York, Beach Erosion Study - 1943. A cooperative beach erosion control study of the Lake Ontario shoreline of Niagara County, NY, was made by the Beach Erosion Board between 1939 and 1942. A report on this study was published in House Document No. 271, 78th Congress, 1st Session. The Niagara Frontier Planning Board requested the study for the purpose of determining methods of preventing further erosion of the Niagara County lakeshore, especially the State highway right-of-way east of Wilson Harbor and beaches on publicly-owned properties at and near Wilson and Olcott, NY. Accordingly, the report included plans of improvement for the highway, for Tuscarora Park, near Wilson, and for Krull Park at Olcott. Typical plans for protection of other reaches of the Niagara County shoreline were also developed in the report.

The report recommended protection of the bluffs by stone revetment or concrete crib seawalls. The construction of groins and placement of sand fill were recommended for the improvement and protection of the parks where public bathing beaches were wanted.

The groin construction done several years later at Krull Park generally conformed to this recommended plan, but the sand fill was not provided.

d. Great Sodus Bay, NY - Section 111 Reconnaissance Report for Shore Damage Attributable to a Federal Navigation Project - May 1977. The objectives of this report were to:

(1) Determine whether or not the Great Sodus Federal navigation structures were responsible for causing or contributing to the erosion problem at Great Sodus Bay.

(2) Determine the extent of the area affected by the navigation works.

(3) Recommend what remedial measures, if any, should be undertaken by the Federal Government to mitigate or prevent erosion damage attributable to Federal navigation works.

The major recommendation of this report was that no further study of the effects of the harbor structures on the adjacent shoreline be accomplished under the Section 111 authority inasmuch as it was determined that the Great Sodus Harbor structures were not causing shoreline damage.

e. Durand-Eastman Park; Rochester, NY - This study was authorized by a resolution of the Committee on Public Works of the U.S. House of Representatives on 14 April 1964. The purpose of the study was to consider necessary measures for the control of erosion and improvement of the bathing beach at Durand-Eastman Park.

Authority was requested on 18 August 1967 to suspend work on the study until a question on the ownership of the entire park frontage could be resolved. The suspension authority was granted on 13 September 1967. During the suspension period, Durand-Eastman Beach along with other public beaches in the immediate area were closed due to deteriorated water quality. This combined with the real estate problem resulted in a revocation of study funds.

4.2.2 FLOOD CONTROL

a. "Operation Foresight" 1973-1974 - In late 1972 when water level forecasts indicated that severe flooding would occur around all of the Great Lakes except Lake Superior, Operation Foresight was authorized in accordance with Public Law 84-99. Temporary flood protective works and flood fighting assistance were offered to areas where such actions were beyond State and local capabilities. Facilities were constructed through contracts awarded by the Corps and self-help efforts by residents using Government-furnished materials.

Numerous communities on the Lake Ontario shoreline were studied to determine their need for protection and the feasibility of such works. Projects (temporary dikes and levees) were ultimately constructed in 14 communities along Lake Ontario. The approximate total cost of this work was $1,140,000. The total estimated damage prevented through 1974 was estimated to be $2,437,000.

4.3 PUBLIC CONCERNS AND ISSUES

In August 1979, a series of five facilitated workshops were conducted along the shoreline of Lake Ontario. These workshops were conducted under contract with Great Lakes Tomorrow, an international citizens organization. They were held at Watertown, Mexico, Rochester, Irondequoit, and Wilson, NY. The primary purpose of these workshops was to identify issues, concerns, and problems relative to the water and related land resources of Lake Ontario, the management of those resources, and the Lake Ontario Shoreline Protection Study itself.

Appendix B - Issues and Concerns provides a detailed listing of the issues, concerns, and problems which were surfaced by the public. A summary discussion follows.

The fact that the study is in an early stage of definition may have contributed to the number of planning issues raised. Participants suggested many elements of a comprehensive planning process that would recognize the inevitability of erosion in some areas. They also suggested that the study: identify all impacts so that the risks of trade-offs are plain, look at the shoreline experiences of other nations such as Holland and Denmark, and make sure that the management system deals with the whole lake rather than just local self-interest.

The lack of coordination among studies and responsible agencies and the absence of a single agency to handle shoreline problems of the public was a consistent theme. The public recognized that the LOSP Study is inevitably related to Winter Naviation, Lake Erie Levels Regulation and the New York State Coastal Management program as well as to local port and harbor studies being conducted by the COE on Lake Ontario. They wanted lake levels, channel depths, and other planning for navigation to be related to shoreline problems in this study. The public also felt that coordination with all other programs such as recreational access and sand mining in the lake needs to be addressed concurrently.

The lack of current and detailed data on shore erosion problems was mentioned. Time sequence and aerial photography were suggested as ways to document recession rates and the erosion process. An inventory of existing protective structures and a determination of the erosion impact of the man-made structures were requested. The relationship of the LOSP Study to the Great Lakes and Canada was posed in a number of ways. Participants were concerned that both upstream and downstream impacts would be considered in the study and there was recognition that all lakes had erosion problems, and that the shoreline should be looked upon as a dynamic system. The multiple user interests and the interest of Canada in any solutions were acknowledged.

Engineering concerns were divided among structural measures and the management of lake levels. Technical advice and education of individual property owners and local governments on the evaluation of erosion problems, construction of structural measures and proper maintenance were identified as needs to which they would welcome timely attention. Participants identified

a need for coordination of structural measures and the application of specific design and performance standards over an extended reach of shoreline rather than allowing individual structures that contribute damage to adjacent shorelines or poorly designed and constructed structures which do not last or which do not function as intended.

Participants felt that the other upstream Great Lakes and the St. Lawrence River needed to be considered together with Lake Ontario in any evaluation of lake level regulation as a remedial measure for Lake Ontario shoreline erosion. Many citizens equated high water problems on Lake Ontario with the construction of the Seaway and the imposition of lake level regulation to assure water depths for power production and navigation in the Seaway. However, they argue both for and against lowering and restriction of the range of levels permitted. There was considerable agreement, however, that the study should be concerned with lake level regulation for the interest of the riparian owners. There was a large amount of frustration with perceived inaccessibility to the St. Lawrence River Board of Control by citizens. The general consensus was that they wanted a riparian owner to represent their interests on the Board. They did not seem to believe that the COE could not affect this kind of decision, but they saw it as being relevant to solving problems via changes in the regulation criteria. (i.e., the COE could not arbitrarily admit them to the Board of Control, but it could develop study recommendations regarding changes in membership and operation procedures for consideration by the IJC).

Environmental issues were distributed among areas such as ecology, geology, land management and hazard lands, water quality, and fish and wildlife. The area of ecology is descriptive of participant identification of relationships and conflict, generally of development by human activities against natural systems of vegetation, barrier reefs, beaches, river currents and wetlands. Erosion is seen as a natural phenomenon, but one which may be prevented by "draining the lake" or walling off the shoreline. The need is expressed for a geological inventory of the shoreline which would identify natural protective features, geologic processes at work and the associated erosion rates. The problems affecting land subject to erosion and flooding were identified in a search for solutions. Bluff seepage, ice, beach nourishment, and building on natural protective features were mentioned. The loss of beaches and the material required to replenish them was a major concern.

Participants identified the impacts of intensive development along the Lake Ontario shoreline since the early 1950's. These included accelerated runoff, erosion, and siltation. It was felt that the impact of land practices needs to be identified. The shoreland was also seen as a valuable agricultural resource and participants felt the need to evaluate the impact of agricultural practices which might impact shoreline erosion processes. Some participants identified the fact that inshore waters of Lake Ontario are an important spawning ground and nursery area for lake fisheries. The wetlands (which were identified as disappearing) were seen as being desirable habitat for waterfowl and other species and to protect the shoreline. Both the inshore waters and the wetlands are affected by changes in lake levels

and there was concern that further manipulation of lake levels would jeopardize the resource. Water quality was also an issue of concern as participants were suggesting that the study identify problems related to the carrying of sediment, nutrients and chemical discharges into the lake as a result of runoff and shore erosion. The problem of toxic pollutants in Lake Ontario was consistently identified as a major environmental problem.

The distribution of costs and benefits, tax policy, legal questions, safety and recreation were the socio-economic issues raised. Many citizens were puzzled over how cost/benefit analysis would be applied to this study and urged that local citizens be allowed to review the factors and criteria. Losses to power production and navigation need to be contrasted to riparian losses under various alternative measures. Compensation for damages and the inadequacy of insurance and previous financial aid programs were also major concerns. Citizens were very concerned about actual or perceived inequities in previous emergency aid programs and did want the study to address means to equalize cost sharing and to ensure that all those eligible received timely information regarding access to such opportunities. The plight of the retiree in being unable to pay for protection measures and the imbalance between the value of the property and the cost of salvaging it from erosion are two examples of the shoreline dilemma.

Both legal issues and tax policies aroused the ire of participants. Some are being taxed on land that is now underwater and is nominally the property of the State. Taxes have not been reduced nor has the loss been recognized for tax purposes. The question of subsidy from county or Federal funds for shoreline protection was argued pro and con. What is the legal responsibility of a riparian owner for the protection of owned property? Is this right changed by public access, by loans, or by relief measures? Some recognized that local interests controlled the pace of development and that lack of land use restriction or enforcement of local zoning/land use policies contributed to the problem. The legal/enforcement questions were also raised.

The limited representation of recreation interests was evident. It was generally acknowledged that existing recreation facilities are overcrowded, boat ramps and harbors being mentioned. Access to beaches and shore recreation was also perceived to be limited. On the other hand, attention was directed toward the seasonal use by the public and the damage done to the shoreline by recreational use. The impact of shoreline protection on the substantial tourism industry in the region needs to be related to the costs and benefits for riparian and other affected interests.

Finally, deterioration of older protective structures was identified as a problem and is exemplified by a police report of an accident caused by a deteriorating structure. Since the Federal Government encouraged structural measures, it was felt that the COE should survey each reach of the shoreline to document the condition of existing structures.

Regional problems were identified by brief case studies provided by participants. These are given as examples of many specific shoreline problems identified and recite the common problems of commercial development

and area destruction, the loss of barrier beaches and dunes due to building, loss of vegetation, use of all terrain vehicles and the like.

Citizens see wetlands being destroyed by filling, building, dredging. The net impact is one of multiple problems, effectively similar from one area of the shore to the next. There is recognition that local action is responsible for some effects, but a feeling of inadequacy against the accumulated ills facing their shoreline. It is in this attitude that a search for or a belief in the simplistic solution (such as: lower the lake level, build a wall) occurs.

4.4 PROBLEMS AND NEEDS

4.4.1 EROSION

Erosion is a natural process and its severity is a function of several factors such as water depth, wind strength, duration, orientation, fetch, and shoreline material. Although it may be an ever-occurring event, usually it manifests itself by storm-induced wave action and may become devastating when storms occur during short and long-term periods of high lake levels. By itself erosion is not a problem, but when associated with shoreline development a conflict between man and nature arises. The severity of the problem is a function of how fast erosion is occurring, the distance which will erode, and the economic value attached to the erosion loss.

One only has to look at the wind and wave climate, and the geomorphic composition of the Lake Ontario shoreline to conclude that the shoreline is erosional. Such a conclusion, when related to the amount and type of development along the shoreline, is indicative of erosion problems. Of course, this manner of such a simplified conclusion is overshadowed by the outcry of shoreline property owners about the problem.

Cognizant of the study's primary purpose which was to address erosion and flooding along the U.S. shoreline of Lake Ontario, efforts were directed at determining the areas where erosion was a problem. This task was made part of the shoreline inventory contract with Great Lakes Laboratory.

a. Rate of Erosion - The rate at which erosion occurs along Lake Ontario varies significantly from one area to another. Vertical aerial photographs taken between 1938 and 1979 were analyzed. Using common points of reference, the rate of erosion or retreat rate at over 400 locations was determined. The average retreat rate for a reach was obtained by averaging the retreat rates of all points of observation (3 to 8) within a reach. Depending on the availability of photo coverage, the period of analysis varied from 25 to 40 years.

The retreat rate for both the shoreline and bluff were calculated. The purpose of separating the two was to identify the influence of any variable other than wave attack which may, in conjunction with or independent of the waves, effect the rates of erosion. The shoreline retreat rate was obtained by dividing the total shoreline retreat between the first and last years of measurement by the number of elapsed years. The points of reference included

bluff crestline, beach scarp line, dune scarp line, or vegetation line. The bluff retreat rate considered only the bluff crestline. Rates were calculated at intermediate periods of time. Values were then averaged over the periods of observation to obtain the bluff recession rate for a specific point. Figure 4.1 provides a generalized indication of the variability of the bluff recession rate along the Lake Ontario shoreline.

It was determined from field observations and later verified from random spot measurements of the rates of retreat of bay shore bluffs that the bay shore bluffs are mostly stabilized by vegetation except the eastern shore of Irondequoit Bay. They are only subject to erosion due to mass wasting, which includes all processes where rock or soil failure is primarily due to gravity. The rate of retreat for Bay shore bluffs is less than 0.5 feet/year.

Long-term retreat rates were also analyzed. Long-term rates refer to bluff recession rates which were computed over a long period (99 years), as opposed to the 25-40 period of the short-term rates previously discussed. The long-term rates which were analyzed were obtained from literature (Drexhage, 1979). They were calculated for the period 1874-1875 to 1974 using Corps of Engineers Lake Survey charts of 1874-1875 and 1974 aerial photographs. Retreat rates were classified as very fast (>4 ft/yr.), fast (3-4 ft/yr.), moderate (2-3 ft/yr.), slow (1-2 ft/yr.), and very slow (<1 ft/yr.). The slow to very-slow rates showed a fair degree of correlation with the short-term rates. In general, the straight lake plain bluffs (reaches 2 to 12) in Western Niagara County, where bedrock is not exposed at the base, show a faster long-term retreat rate than the bluffs of the same geomorphic unit with exposed rock at the base. A similar trend of long-term retreat rates being faster or larger than the short-term rates occurs along the eroding headland unit of Monroe County (reaches 26 to 37). The accuracy of the 1874-75 charts and the scale variations of the 1974 photos would lead one to question the reliability of the long-term rates. Short-term rates are more indicative of what is presently happening along the shoreline especially when considering the amount of shore protection which has taken place in recent years and changes which have occurred to the level regime of the lake.

b. Identification of Erosion Hazard Areas - The problem of erosion is generally one of perception. A loss of 6 inches of shoreline a year may be perceived by one person as a problem, whereas his neighbor may not perceive such an erosion loss as such. Thus, in identifying erosion hazard areas it was necessary to define the term "hazard area." Considering that the severity of erosion as a problem is a function of the rate at which the erosion is occurring, the distance the shoreline must erode to reach shoreline development, and the economic value of that development, criteria were established to define erosion hazard areas. An area was considered to be a hazard area if it met the following criteria:

(1) the short-term or long-term retreat rate must be greater than 1 ft/yr, or

(2) the shoreline would reach the structure in less than 100 years due to erosion, and

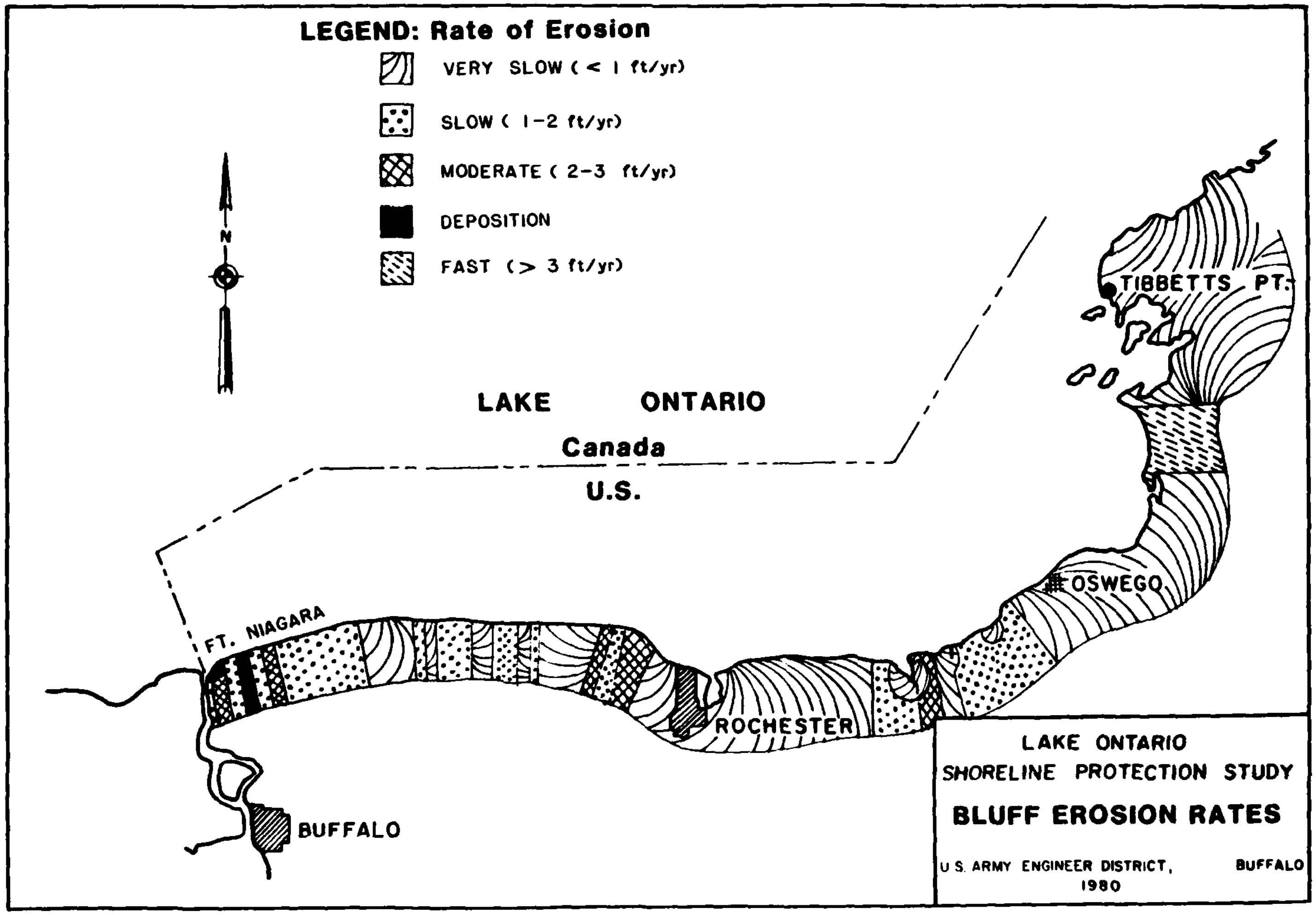

LEGEND: Rate of Erosion
VERY SLOW (< 1 ft/yr)
SLOW (1-2 ft/yr)
MODERATE (2-3 ft/yr)
DEPOSITION
FAST (> 3 ft/yr)
N
LAKE ONTARIO
Canada
U.S.
FT. NIAGARA
BUFFALO
ROCHESTER
OSWEGO
TIBBETTS PT.
LAKE ONTARIO
SHORELINE PROTECTION STUDY
BLUFF EROSION RATES
U.S. ARMY ENGINEER DISTRICT, BUFFALO
1980

Figure 4.1

(3) the market value of the shoreline development was greater than $150,000/mile.

Criteria (3) was used to weed out undeveloped areas. These areas, such as agricultural lands, will be analyzed separately during Stage 2. The above criteria was supplemented with consideration given to areas which were envionmentally, culturally, or socially significant, and to areas considered critically erosional by the NYS Coastal Zone Management Program. Realizing the length of shoreline and the amount of development thereon, it was not possible during Stage 1 to analyze each individual parcel of land; therefore, the identification of erosion hazard areas considered only those areas which had at least two structures per 200 feet of shoreline. Using the above criteria 46 erosion hazard areas were identified. These areas are indicated in Table 4.1. The mileage limits of the areas in Table 4.1 are only approximate.

Table 4.1 - Erosion Hazard Areas

Area	Shoreline Mileage	Reach Number
Harrison Grove	283.50 - 284.50; 285.00 - 285.25	4
Uneeda Beach	281.50 - 281.75	5
Hopkins Beach	281.00 - 281.25	5
Sunset Beach	278.10 - 279.00	6 & 7
Tuscarora Bay	277.40	8
Unnamed Community	275.25 - 275.50	10
Unnamed Community	274.15 - 275.00	10
Olcott	270.75 - 271.75	11 & 12
Natural	258.75 - 259.00	15
Unnamed Community	257.75 - 258.00	16
Natural	249.00 - 249.40	20
Lakeside	248.00 - 248.50	20 & 21
Point Breeze	244.00 - 244.25	22
Jones Beach	241.50 - 242.25	22
Lomond Shore	238.50 - 240.50	22 & 23
Natural	234.10	26
Oneto Beach	229.75 - 230.50	28
Sandy Harbor Beach	228.75 - 229.50	28 & 29
Benedict Beach	227.25 - 228.25	29
Shore Acres	226.00 - 227.00	30
Wautoma Beach	224.50 - 225.50	31
Davidson Beach	222.50 - 222.75	34
Lighthouse Beach (W)	222.25 - 222.50	35
Lighthouse Beach (E)	222.00 - 222.25	36
Bogus Point	221.75 - 222.00	36
Payne Beach	220.00 - 221.25	36A
Manitou Beach	218.50 - 219.00	38
Oklahoma Beach	207.00 - 207.25	45A
Forest Lawn	206.25	46
Nine Mile Point	202.00 - 202.50	49
Ontario-on-the-Lake	198.00	52
Unnamed Community	196.50	52
Pultneyville	188.00 - 188.50	55
Holland Cove	186.00 - 186.75	55
Charles Point	175.25 - 176.25	69
Moon Beach	156.25 - 157.00	84
Camp Oswego, Natural	139.00 - 145.50	88
Shore Oaks	138.00	89
Dempster Beach	135.00 - 135.25	89
Mexico	132.00	90
Ramona Beach	129.00 - 131.50	91
Salmon River Inlet	127.75 - 128.00	91
Selkirk	127.00 - 127.75	91 & 92
Rainbow Shores	125.00 - 126.50	93
Montario Point	119.50 - 120.00	96
Jefferson Park	111.00 - 115.00	96

4.4.2 FLOODING

Flood damages along the Lake Ontario shoreline can generally be divided into two categories:

a. those resulting from inundation due to the level of the lake; and

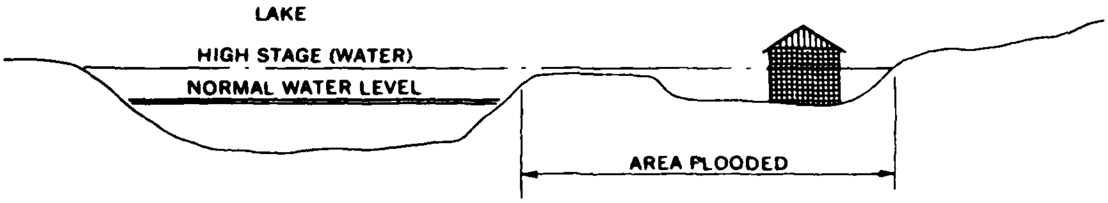
b. those resulting from inundation and impact damage from waves.

High lake levels may result from periods of high precipitation which may last for months or from atmospheric conditions such as storms and high pressure systems. The latter are usually of short duration, i.e. one or two days, and cause the level to the lake to rise at one end and lower at the other. The amount of lake level rise due to a storm is a function of the strength and duration of the wind and the length of fetch. The fetch is the length of water surface over which the wind blows.

Damages due to waves may occur at any lake level, but cause their greatest devastation in conjunction with high lake levels. The storm of 17-18 March 1973 occurred during a period of high lake levels due to precipitation, whereas the storm of 5-6 April 1979 caused a damaging setup at the eastern end of the lake. In cases where development is very close to the shoreline, waves can produce damage by impacting on the structure, and by inundation resulting directly from the wave or ponding of wave upwash in low land areas. Figure 4.2 shows the various types of flooding experienced along Lake Ontario.

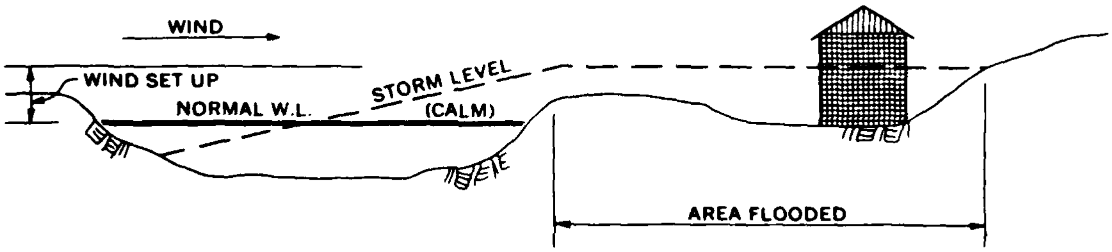
Generally the areas of greatest flood damage are western Monroe County and Sodus Point. As part of this study it was necessary to identify areas which were floodprone along the shoreline. This was done by researching areas which were identified during "Operation Foresight" and newspaper articles. These were augmented with actual structure elevations, Federal flood insurance maps, input from public workshops, and field reconnaissance. Table 4.2 identifies those areas which were determined to be floodprone.

A. FLOODING DUE TO HIGH, CALM WATER STAGES (MEAN MONTHLY)



CALM WATER LEVEL BELOW LAND CREST. HIGH WATER EXCEEDS LAND HEIGHT.

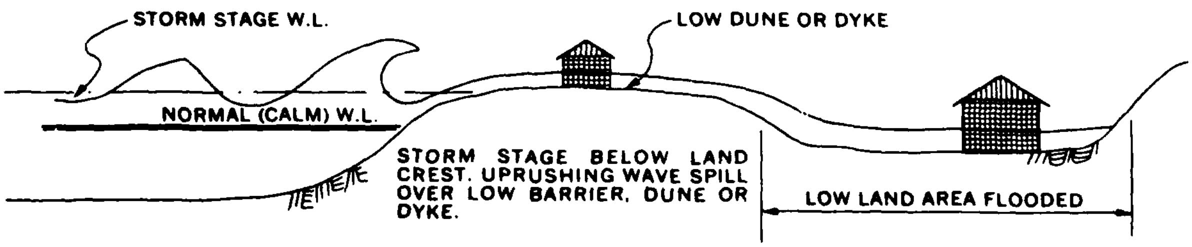
B. STORM STAGE FLOODING



CALM WATER LEVEL BELOW LAND CREST. STORM WATER LEVEL EXCEEDS LAND HEIGHT.

THE PRINCIPAL DIFFERENCE BETWEEN A & B IS THE DURATION. IN A., THE DURATION MAY BE ONE TO SEVERAL MONTHS. IN B., THE DURATION IS USUALLY ONLY SEVERAL HOURS, ALTHOUGH IT MAY REMAIN LONGER, DEPENDING ON DRAINAGE BACK INTO LAKE.

C. WAVE UPRUSH FLOODING



USUALLY OF SHORT DURATION AND LOW WATER COVER IN AREA FLOODED. AMOUNT OF FLOODING DEPENDS ON STORM SEVERITY AND DURATION

TYPES OF FLOODING

Source: Regulation of Great Lakes Water Levels, I.G.L.L.B., 1973

Figure 4.2

Table 4.2 - Floodprone Areas

Area	Shoreline Mileage	Reach Number
Olcott Harbor	271.30 - 271.40	12
Point Breeze	243.80 - 244.10	22
Jones Beach	242.00 - 242.50	22
Brockport Filtration Plant	230.40 - 230.60	28
Newco Beach	228.80 - 229.00	28
Sandy Creek	228.80	28
Sandy Harbor	228.50 - 229.00	28 & 29
Benedict Beach	227.30 - 228.00	29
Shore Acres	226.30 - 226.90	30
Wautoma Beach	224.20 - 225.10	31 & 32
Cranberry Pond	216.90 - 217.70	38
Grandview Beach	216.40 - 217.20	38
Long Pond (W)	216.30 - 216.80	38
Braddock Heights Bay	217.60 - 219.10	38
Crescent Beach	215.20 - 216.00	39
Oklahoma Beach	207.20	45A
Nine Mile Point	202.20	50
Sodus Point	176.90 - 180.70	58
Sodus Bay	175.20 - 177.00	59 - 68
Lakeview	142.00	88
Dempster Beach	135.10 - 135.70	89
Mexico Point	132.40 - 132.60	90
Ramona Beach	130.00 - 130.50	91
Green Point	121.00 - 121.20	94 & 95
Ray Bay	105.00 - 107.00	99
Boomer Cove	105.40 - 105.80	99
Boulton Beach	85.20 - 85.70	105 & 106
Sherwin Bay	66.00 - 67.10	109 - 110
Braddock Heights	217.60 - 217.90	38
Island Cottage Beach	214.40 - 215.10	40
Manitou Beach	219.20 - 219.40	37
Payne Beach	220.20 - 221.10	36A
Bogus Point	221.80 - 222.10	36
Lighthouse Beach	221.10 - 222.40	35 & 36
Wautoma Beach	224.30 - 225.00	31 & 32
Davidson Beach	222.50 - 222.90	34
Hilton Beach	223.30 - 223.80	32 & 33
Salmon Creek		38

4.4.3 PUBLIC ACCESS

Public access to Lake Ontario is a key issue especially to those who are nonresidents of the shoreline, but wish to enjoy its aesthetic and recreational resources. This access can be in the form of public facilities along the shoreline such as beaches and marinas. These are discussed in this section under Recreation. It may also be in the form of physical access to the general shoreline which is discussed here.

Development and private ownership of the shoreline provide the greatest impediment to shorefront access for the general public. This is compounded by the amount of shoreline which is inaccessible due to physical features and topography. Cliffs and steep bluffs, while providing scenic value, limit access to all but the ambitious. Based on the number of parcels of land, private ownership varies from 83 percent in Cayuga County to 99 percent in Orleans County. Again based on the number of parcels, recreational land use varied from 1 percent in Orleans County to 16 percent in Cayuga County. With property rights extending to the water, lateral access along the shore is also restricted. Land use practices and location of public thoroughfares limit the visual access of the lake. Development patterns and structural designs may block the view of the shoreline or affect the landscape. These thoroughfares may also prevent physical access to the shoreline. The Lake Ontario State Parkway in eastern Orleans County and western Monroe County provides excellent visual access, but prevents physical access.

Opposition from coastal communities and shoreline residents impede efforts to increase access to the shoreline. This opposition is based upon several factors such as increased pollution, noise and litter, undesirable commercial development, conflicts between uses, a decrease of property value, traffic congestion, and vandalism to private property. As a result, where access is available via roads or rights-of-way, nonresidents usually find "no trespassing" signs, or where access is permitted to the shoreline, "private beach" signs deter access along the shoreline.

Another aspect of this problem is access to existing and future facilities. Many of the public facilities such as parks, beaches, boat launching ramps are situated in suburban or rural areas which because of their location may be inaccessible to the urban public or may discourage their use. Inadequate parking facilities may also be a factor especially during periods of high use such as on holidays. Capacity of a recreational facility may in fact be dependent upon its parking, such as a boat launching ramp.

Restrictions placed upon the use of a recreational area also make the shoreline inaccessible to the general public. Such restrictions limit access to local residents at several locations along the shoreline. Access may also be restricted by having no parking on streets adjacent to an area, or charging fees for nonresidents for access or parking.

4.4.4 RECREATION

As mentioned in Section 4.4.3, one aspect of access needs is that of facilities, whether they be a point of land that overlooks the lake or a

large State park. Both public and private sectors have striven to provide these facilities. For the most part their roles are defined with little overlap. Beaches have customarily been the role of the public sector, whereas marinas have generally been provided by the private sector. Problems sometimes develop where both are competing such as with camping facilities or boat launching facilities. Low cost or free public facilities may put a private facility out of business. By creating economic problems for the private sector, less service is provided to the public and new facilities are discouraged. Laws and restrictions placed on the use of public lands also play a role by not allowing the development of certain facilities by the private sector, or where this is allowed such development may be restricted in size by the length of a lease.

Conflicts with other land uses cause problems for providing recreation facilities. The amount of existing shoreline, the density and type of development, and the type of recreation facility are the major components of the conflicts in shoreline use. This is most evident in urban or suburban areas where competition for shore land is usually won by commercial and residential uses who are able to compete for the high prices of such land. Conflicts of use are also reflected, for example, when one use such as industry contributes to a water quality problem, thus making an area unsuitable for swimming. Water quality problems are discussed later in this section.

Coastal processes also present problems to recreation. The littoral transport often causes sand bars to close openings to bays and creeks, preventing access by boats and presenting a hazard to navigation.

Excessive use of an area may destroy the recreational resource. This is closely related to the need for additional facilities. If additional facilities are not provided, present ones will become over used, and fragile areas, such as the dune areas and wetlands along the eastern shore, may feel the wrath of increased recreational pressures.

The growing salmonid fishery, which has been implemented by NYS Department of Environmental Conservation, has and most probably will continue to increase the need for fisherman access along the shoreline. There is also an accompanying need for boating facilities, especially safe harbors-of-refuge. Both the public and private sectors have strived to provide adequate fishing and boating facilities, but there are many areas along the shoreline where demand exceeds the supply. Table 4.3 shows the major areas which are in need of fishing access sites and fishing piers. Table 4.4 gives the areas where there is a desire for future development of boating facilities.

Urban areas generally exhibit the greatest deficiencies along with the greatest use of existing facilities. This is due to their greater population. Poor water quality, high land costs, competitive uses of the land, and access all contribute to the deficiency of facilities and the high use of existing facilities. Because of population growth in areas such as Rochester and Webster, the future demands for facilities will compound deficiencies of recreational areas available.

Table 4.3 - Major Fishing Access Needs

Lake Ontario/St. Lawrence

Orleans
- *Lakeside+
- *Oak Orchard

Oswego
- *North Sandy Pond+
- *Salmon River+
- *Oswego Harbor+
- *Nine Mile Point
- *Deer Creek
- *Little Salmon River+

St. Lawrence
- *Chippewa Bay+
- *Morristown
- *Grass River at Massena Center
- *Raquette River

Wayne
- *Sodus Bay+
- *Bear Creek
- *Maxwell Bay
- Red Creek+
- *Port Bay+

* Fishing Access Site Needs
\+ Fishing Pier Needs

Source: Public Access and Recreation Within the Coastal Boundaries of New York State: New York State Office of Parks and Recreation, March 1978.

Table 4.4 - Major Boating Needs

Lake Ontario/St. Lawrence

Cayuga
- Fair Haven

Jefferson
- Stony Point Area
- Henderson Bay
- Long Point State Park
- Sackets Harbor

Monroe
- Braddock Bay
- Irondequoit Bay

Niagara
- Olcott Harbor
- Golden Hills State Park
- Fort Niagara
- Four Mile Creek
- Wilson Tuscarora

Orleans
- Oak Orchard

Oswego
- Oswego Harbor
- Mexico Point
- Port Ontario
- Selkirk Shores State Park
- North Sandy Creek

St. Lawrence
- North of Ogdensburg
- Coles Creek State Park

Wayne
- Sodus Bay
- Chimney Bluffs
- East Bay
- Port Bay

Source: Public Access and Recreation Within the Coastal Boundaries of New York State: New York State Office of Parks and Recreation, March 1978.

4.4.5 LAKE LEVEL REGULATION

Lake Ontario outflows have been regulated by the International Joint Commission since April 1960 by use of the St. Lawrence Seaway and Power Projects. Such regulation is conducted by the International St. Lawrence River Board of Control in accordance with the IJC's Orders of Approval dated 29 October 1952 and 2 July 1956. The Orders of Approval set out a series of criteria by which regulation was to be accomplished. Generally, the levels of the lake are to be regulated between a range of monthly mean stages of 242.8 feet and 246.8 feet (IGLD) during the navigation season, as nearly as may be. The phrase "as nearly as may be" demonstrates that the Commission realized that it might not be possible to satisfy all of the criteria all of the time. The IJC implemented various progressively improved plans for regulating the outflows from Lake Ontario, namely Plans 1958-A, 1958-C, and the present Plan 1958-D. More detailed discussion of lake level regulation is provided in Section 2.8.

a. Extreme Supplies - Since its implementation in 1963, the operational plan for regulating the outflows of Lake Ontario has been Plan 1958-D, supplemented with the discretionary authority which was granted to the International St. Lawrence River Board of Control by the IJC. The plan has been developed to provide greater benefits to all interests while satisfying the criteria and other requirements which have been established.

During the design of the St. Lawrence Seaway and Power Projects it was known that certain modifications would be necessary to the river channel to satisfy certain criteria. Channel enlargements were necessary to provide adequate depth and safe channel velocities for the larger ships which would be traversing the system, and to reduce the river velocity in certain reaches so that an ice cover could be formed on the river during the winter. The design of the channel enlargements was done utilizing Plan of Regulation No. 12-A-9 as the basis for calculating water surface profiles. The test of Plan 12-A-9 over the 1860-1954 period demonstrated that the Orders of Approval could be met with the channel enlargements which were constructed as part of the projects.

It was realized, however, that at some time in the future, Lake Ontario might receive supplies more extreme that those of the past which were used to design the channels. Therefore, criterion k was included in the Orders to define the objectives of regulation in the event of such extreme conditions. Criterion k mandates that when supplies are in excess of those on which the plan was tested, regulation shall be conducted "to provide all possible relief to the riparian owners upstream and downstream" from the project, when supplies are less than those on which the plan was tested, regulation shall be conducted "to provide all possible relief to navigation and power interests."

Since 1960 there have been two periods when supplies were in excess of or less than those of the past. During 1961 - 1964 the Great Lakes experienced a drought. Supplies to Lake Ontario were inadequate for the plan of regulation to satisfy all of the criteria. Subsequently, during the 1972-1978 period abnormally high precipitation occurred over the basin

causing supplies to Lake Ontario in excess of those of the past. In both cases Plan 1958-D could not cope with the conditions and criterion k had to be implemented.

The inability of the plan of regulation to provide lake levels within the 242.8 - 246.8-feet range during the unprecedented supplies of the 1960's and 1970's is a function of both the hydraulic capacity of the St. Lawrence River and the Orders of Approval. During these periods, especially the high supply periods, the Orders of Approval can not be fully met with the existing capacity of the river. If the existing Orders of Approval are to be fully met, then the capacity of the river must be increased.

b. Range of Levels - Each interest affected by the regulation of Lake Ontario responds differently to the level of the lake. Such response even differs among the same interests. Therefore, the desire for a specific water level or range thereof differs widely along the shoreline. A major concern is that the level of the lake is not being managed properly because it is not at the level desired by that interest. Some interests such as some riparian owners would desire levels to be held constant and low enough to protect their property from damage during storms, yet high enough to not effect their recreaton. Other such owners would desire higher levels for access by boat to their embayment cottages. Recreationalists desire higher levels for access to marinas, rivers, and embayments. Environmental interests generally desire a seasonal fluctuation of level, but one which is not extreme.

Associated with fluctuating levels are those interests who desire levels to fluctuate freely within the range of regulation (242.8 - 246.8 feet), utilizing the full 4-foot range. Commercial navigation desires levels which will provide adequate draft in harbors, while on the St. Lawrence River these interests require levels which in combination with outflows, do not provide excessive currents, and provide adequate draft. Generally, lake levels and their range of fluctuation, whether seasonal or long term, may always be a point of contention due to the varied interests involved.

c. Representation - The International St. Lawrence River Board of Control was established by the IJC to monitor the operation of the St. Lawrence Seaway and Power Projects to insure compliance with the requirements of the Orders of Approval. In doing so, the Board is responsible for advising the Power Entities (Ontario Hydro and the Power Authority of the State of New York), of the recommended weekly outflow from Lake Ontario. The Orders of Approval also state that the Board should develop and make provision for adjustments and progressive improvements to the plan of regulation. The Board is made up of four members each from the United States and Canada. They are appointed to the Board by the IJC based up their technical expertise. The following are the present members of the U.S. and Canadian Sections of the Board.

United States Section	Canadian Section
Brigadier General Scott B. Smith (Chairman) U.S. Army Corps of Engineers	Mr. Ralph H. Smith (Chairman) Canadian Department of Transport
Mr. Daniel J. Palm St. Lawrence-E. Ontario Commission	Mr. Robert H. Clark Environment Canada
Mr. William H. Kennedy St. Lawrence Seaway Dev. Corp.	Mr. Mortimer Hendler Quebec Dept. of Nat. Resources
Mr. John Bartholomew Power Authority of the State of New York	Mr. Roy A. Walker Ontario - Hydro

Their membership on the Board is as individuals and not as representatives of their respective agencies.

A major criticism of the Board by the riparian interests along the shore is that the level of Lake Ontario is not being regulated properly. This criticism has been particularly prevalent since the high water period of the 1970's. To many of the riparian interests, the high lake levels and resulting damages were experienced to the benefit of power and navigation. Their conclusion is that the members of the Board are not divorcing themselves from their agency, but are representing the interests of their agency. As such they feel the Board only represents the interests of power and navigation. It is believed to be a general consensus among riparians that in order for regulation decisions to be reflective of their interests, a U.S. and Canadian riparian representative must be appointed to the Board. An extension of this feeling is also the consideration of representation for the environmental and recreational interests, as well as the riparian interests downstream of the project. The desires of these particular groups are not always in consonance.

4.4.6 FISH AND WILDLIFE

Fish and wildlife resources of Lake Ontario and its shoreline are recognized for their food, aesthetic, and recreational value. Their coastal habitats are important; therefore, the protection and management of the fish and wildlife resource is dependent upon conserving and/or improving these habitats. Certain habitats, because of their nature, are more significant than others and need more specific attention. The loss of these significant habitat, which may serve as breeding or nursery areas, or temporary resting sites for migratory waterfowl, may provide a greater threat to the survival of a population than certain other habitat. The loss of such significnat habitats is of national and Statewide concern.

Along Lake Ontario, wetlands are the type of habitat which has been most adversely impacted. This has resulted from dredging and filling operations and associated changes in land use. The losses are usually due to agricultural, residential, and commercial development. Much of Lake Ontario's wetlands are privately owned. Although people are becoming more aware of the value of wetlands, adequate incentives are not presently available to encourage private land owners to preserve wetlands. Removal of

upland habitat for development and agriculture may also affect wetlands by altering runoff rates so that water temperatures and volumes change, and stream bank erosion and sedimentation increase. Additionally, disturbance to upland and shoreline areas may silt in fishery spawning habitats. Stream bank erosion and alterations of stream vegetation is very critical to the salmonid fishery, especially in eastern Lake Ontario tributaries. Lake erosion is also detrimental to the aquatic habitat. High lake levels allow larger waves in the littoral zone causing increased bottom scour and loss of valuable fish habitat. Erosion can also affect barrier beaches which protect wetlands.

Utilization of the fish and wildlife resources is hampered by access to the resource base. Public access areas are needed. Increased development and posted lands have limited hunting areas and access to streams and the lake for fishermen. Water quality not only affects the quantity of the fish and wildlife resource, but may place restrictions on its utilization, as with the Mirex contamination. Algal blooms in embayments reduce oxygen as do nutrients and waste products.

4.4.7 WATER QUALITY

The main body of Lake Ontario is classified "A" for drinking water quality. Many communities use the water from the lake as a source for their water supply. The lake water is also used for water contact recreation. The ecosystem of the lake is critically dependent on the water therein. Therefore, the quality of the water and the problems associated with it are detriments to its use and the quality of its ecosystem.

Generally, the most prominent factor of recent years associated with the water quality of Lake Ontario has been the discharge of toxic chemicals, either directly or through influent tributaries. These toxic chemicals although in minute quantities are incorporated into the body tissues of aquatic organisms. In 1970 mercury levels exceeded established limits. 1974 saw polychlorinated biphenyls (PCB's) reach high enough concentrations in some fish that health warnings were issued. In 1976, Mirex concentrations reached levels whereby restrictions were placed on the possession of certain sport fish. Such restrictions place an economic burden on areas such as eastern Lake Ontario and the St. Lawrence River where fishing plays a very important role in the economy of the area.

Water Quality problems have limited access along the Lake Ontario/St. Lawrence River coast. Eutrophication, nutrient concentrations, and sewer outflow have restricted recreational use of many embayments and nearshore waters of Lake Ontario. The presence of toxic compounds in the lake has severely restricted fishing opportunities. Sewage effluent discharges have deterred recreational activity along the St. Lawrence River by reducing recreational quality. Table 4.5 shows the areas that could be reopened to recreational activities in the future if water quality is improved.

Table 4.5 - Major Areas of Potential Change in Recreation Opportunities Due to Future Water Quality Improvement

Lake Ontario/St. Lawrence River

Jefferson
- Chaumont bay
- Black River Bay

Monroe
- Irondequoit Bay
- Rochester-Durand Eastman Beach
- Braddock Bay

Niagara
- Niagara River
- Fort Niagara State Park
- Wilson Tuscarora State Park

Oswego
- Oswego City
- Oswego Harbor
- North Pond

St. Lawrence
- Ogdensburg Bay

Wayne
- Little Sodus Bay

Source: Public Access and Recreation Within the Coastal Boundaries of New York State: New York State Office of Parks and Recreation, March 1978.

The following is a discussion of water quality problems associated with various sections of the shoreline.

a. Niagara - Orleans Counties - There are areas which have high coliform values from sewage material. This is partly due to poor treatment at wastewater treatment plants and overflows of untreated wastes during periods of storms. There is some turbidity near the mouth of major streams. Nonpoint discharges from rural or agricultural lands contribute nutrients to the water. Some algal growth is associated with this shore, but is not a nuisance.

b. Monroe County - The Genesee River is the major contributor to the degraded water quality of this area. Its turbidity plume is always evident and indicative of the sediment which is carried from many miles inland. It carries a great deal of nutrients and high coliform loadings. As a result, several public beaches near its mouth have been continually closed since 1967. Irondequoit Bay experiences high eutrophic conditions due to high nutrient inputs from influent streams and peripheral development.

c. Wayne - Oswego Counties - Problems associated with water quality are similar to the Niagara - Orleans County areas. Because of the several thermal and nuclear power plants, thermal discharges may affect or alter the coastal resources. There is some turbidity due to influent streams especially during periods of high runoff. Nutrients from agricultural runoff are a specific problem to the many embayments in this area. Problems with algal and other aquatic weed growth resulting from the high nutrient runoff causes a deterioration of the quality of the embayment water for drinking and problems associated with recreational boating. The Oswego River, like the Genesee River, drains a very large inland area providing much sediment and nutrients to Lake Ontario. The harbor at its mouth requires continual dredging, which resuspends many contaminants in the water column. The offloading of No. 6 fuel at the harbor for the nearby Niagara Mohawk Power Plant makes the area vulnerable to oil spills.

d. Jefferson County - The water quality problems in this area are associated with the embayments. Black River Bay is highly eutrophic due to high phosphorous loadings from the Black River and the shallow depth of the Bay. Chaumont Bay has high levels of phosphorous and nitrogen. High levels of coliforms are also found in localized areas. Algal blooms and aquatic weeds affect water quality and hamper boating.

4.4.8 UNPLANNED DEVELOPMENT

The development along the shoreline of Lake Ontario, for the most part, has been unplanned and uncontrolled. Barrier beaches, which play an important part in the water/land interface of the shoreline, have in places succumbed to the pressures of development. Areas such as the town of Greece and Sodus Point have resulted from uncontrolled and unplanned or inadequately planned development. Their development has been intensive and not adoptive to the rigors of the shoreline. In many cases, homes have been built within a few feet of the water's edge. Building codes have not been used to provide adequate height and setback needed to prevent damage from waves and lake levels.

Shoreline planning has failed to provide access for other uses. Parks and other recreation areas were not included in plans for much of the development which has occurred.

Much of this uncontrolled development has meant a vast loss of wetlands. The dune areas along the eastern shore have been reduced to mere beaches and areas for residential development.

Many residential areas do not have municipal wastewater treatment, therefore, private septic systems are necessary. In areas of heavy development this has contributed to water quality problems, especially in embayments. In some areas development has been so uncontrolled that they have become aesthetically unpleasing. Individual shore protection has also contributed to this.

4.4.9 INFORMATION

From the conduct of the workshops for this study it is evident that the problems associated with the topic of information is twofold. The first is the lack of information, generally in regard to the shoreline property owner, but also with respect to the various agencies having jurisdiction or interest in the shoreline. The most pronounced need for information is relative to shoreline protection, and more specifically, what will work best in "my" case. The techniques associated with such construction are lacking by the construction industry as a whole. This was evidenced during the high water period of the 1970's. Many homeowners spent much of their life savings for shore protection which because of inadequate design and construction was destroyed. Information about coastal processes would be helpful and necessary to complement the aforementioned. These problems have been addressed to some extent by the Corps of Engineers and New York Sea Grant Institute. The Corps of Engineers has published a pamphlet entitled Help Yourself which provides a brief description in layman's terms of the causes of erosion and solutions which can be built to afford protection to the shoreline property owner. The New York Sea Grant Institute conducted a workshop in Mexico, NY, in August 1979 whereby the Corps of Engineers assisted property owners in identifying their shoreline problems and provided suggestions as to their solution. New York Sea Grant is also developing a Coastal Structures Construction Manual. This manual is geared to the design/construction industry to assist them with the required technology needed for sound coastal construction.

The perplexing number of International, Federal, State, regional, and local agencies, their overlapping jurisdiction, and their vast number of programs are confusing and sometimes frustrating to the general public and agencies. A concise description of agencies and their programs needs to be developed to address the public's problems and needs and to be made readily available to the public. Publications such as Governmental Jurisdictions of the New York Coastal Zone by P.D. Marr and E.K. Schuler, and Inventory and Analysis of Existing State and Federal Legislated Programs and Activities Relative to New York's Coastal Zone by New York State Department of Environmental Conservation. Both publications are excellent compilations of the institutional framework of New York's coastal zone, but they have been

prepared on a programatic basis and serve to assist agencies more than the general public. Also, they are not readily available to the general public.

Many residents desire riparian access to lake level regulation. Representation on the International St. Lawrence River Board of Control is the primary means desired and is discussed in Section 4.4.5.c. The other means of access to regulation is information on the decisions which are continually being made regarding the outflows from the lakes. Some riparians feel that they see the affects of regulation, but this is usually well after the decisions have been made. They believe that information should be readily available to them at the time the decisions are made to allow them the recourse of complaint. Presently, the decisions of the Board regarding regulation are made available to local Congressional offices and county Civil Defense offices which have requested this information. During periods when the Commission has exercised Criterion K, press releases have been issued to notify people of its action.

In addition to the need for information, the second aspect of the problem is that of misinformation. This includes such things as how the Great Lakes work, the manner in which regulation is accomplished and decisions made thereof, how other interests relate to lake levels, the use of Lake Ontario's resources, etc. Misinformation or erroneous information can create a problem in one's mind when in actuality the problem does not exist. Misinformation may also be used to reinforce a particular stand on a certain topic or issue, or to muster support to one's side. Misinformation clouds the issues and can make problem or issue resolution sometimes impossible. Its solution is tied to that which has been previously discussed here, that being through the provision of accurate and understandable information which is easily accessible by the public.

4.4.10 AESTHETICS

One of the major resources of Lake Ontario and its shoreline, and probably the most appreciated, is the aesthetics they provide. Whether it is the water, waves on the shore, a scenic view, or a historic site, they provide both an inherent value and augment the value of other uses, e.g. enhancing the attractiveness of an area to vacationers and the quality of the recreation experience. Areas such as historical sites also provide educational values.

The problems associated with the aesthetic quality of the lake and its shoreline are relative to other problems previously discussed. Visual access is limited by shoreline development and restrictions placed on public access. Public thoroughfares are sometimes miles from the shore. Utility lines and billboards can destroy a coastal scene. Visual blight may result from unplanned development, or building practice not conforming with surrounding land forms, or deteriorating buildings along the shoreline. Water quality and pollution have profound effects on aesthetic appreciation. Varying perceptions of aesthetic values and methods for defining and quantifying them have lead to resources being unsystematically inventoried. This has in turn led to their disregard in planning decisions.

4.4.11 AGRICULTURE

There are two basic problems associated with agriculture along the shoreline of Lake Ontario. The first is the loss of production farmland to other uses such as residential development. This is not a problem which is isolated to the Lake Ontario shoreline, but is of national concern. Although the loss of farmland along Lake Ontario has slowed, it remains a problem. This is compounded by the fact that much of the existing farmland in the coastal counties of Lake Ontario is listed as prime. Its loss is therefore of great concern.

The other problem associated with agriculture is its impact on water quality. Although the significance and magnitude of agricultural activities on nonpoint water pollution is not completely known, problem areas which can be associated with them have been identified. The first is sedimentation which may result from erosion of farmlands due to poor farming practices. This sediment is carried to the lake by tributary streams. Turbidity of the nearshore area will retard light penetration and thus, vegetative growth. Siltation of the bottom may also cover fish spawning beds. Turbidity of the nearshore area also affects the attractiveness of an area for recreation. The second water quality problem area which may be impacted on by agriculture is nutrient enrichment. Such enrichment causes eutrophication or aging of a water body. Algal blooms and aquatic weed problems result which affect the quality of the water for water supply, recreation and other uses.

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SECTION 5
CONSTRAINTS AND OBJECTIVES

LAKE ONTARIO SHORELINE PROTECTION STUDY

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CONSTRAINTS AND OBJECTIVES

The Federal interest in natural resources is founded on the principle that they are the basis of our national wealth and future well-being. The goal of Federal participation in the planning, management, and development of these resources is to insure an optimum contribution to the welfare of the people, both now and those to come. The degree of Federal concern for these resources has been established over the years through a developing body of law. Such laws have established the Federal interest and its role in such areas as national parks, endangered species, water quality, flood control, energy, etc. Federal policy seeks to maintain a reasonable balance between the power and responsibilities given to the Federal Government and those which rest with the States, local government, and private enterprise. Legislation expresses the priority goals and objectives of the people, and is implemented by the various Federal agencies. These laws govern agency activities providing agencies their responsibility relative to natural resources.

The Department of the Army and the Corps of Engineers are charged by Congress with the major Federal program of water resources development. It is because of this role or mission that Congress has directed the Corps to conduct the Lake Ontario Shoreline Protection Study. Therefore, the problems, needs, and concerns identified in Section 4 are only those which relate to the water and related land resources of the Lake Ontario shoreline. Problems and needs of other land resources are addressed by other agencies' programs.

The problems, needs, and concerns identified in Section 4 are limited further by various other constraints. These constraints when applied to Section 4 establish the objectives of the study.

5.1 CONSTRAINTS

In conjunction with the Corps mission which limits problems and needs of the study to those of water and related land resources, the authority for the study (Section 1.1) specifies that the study is to develop a plan of shoreline protection for Lake Ontario, cost-sharing relative to such a plan, and recommendations for lake level regulation. This essentially requires that the study address these three issues concerning the problems and needs of the shoreline, i.e., those water and related land resources problems as limited by the authority of the study.

It must also be recognized that the study has been authorized unilaterally by the U.S. Congress, but is a study of a binational resource. Unilateral study authority constrains the study to the problems and needs of the U.S. shoreline. Coordination with Canada and the International Joint Commission is further constrained by diplomatic protocol. This lack of coordination with Canada will affect the detail of the lake level analysis somewhat. This will be especially evident in the assessment of Canadian impacts. The Corps affiliation with various IJC boards and committees will serve as the means of Canadian coordination and should provide information

which will be sufficient for the detail necessary in a unilateral study of this nature. This latter statement is based on the fact that the aspect of this study requiring Canadian coordination is lake level regulation for which this study cannot recommend implementation authority. This will require a joint study with Canada via the IJC, whereby the level of detail necessary for implementation would be provided.

Section 180 of the Water Resources Development Act of 1976 limits the total cost of the study to $2,000,000. Considering the size of the study area, which is approximately 300 miles of Lake Ontario shoreline, and the number of measures available for protecting the shoreline, it will be necessary to limit the level of detail of certain aspects of the study. Alternative plans, which could be implemented directly as a result of this study, will receive the necessary level of detail. Those which will require further study such as the lake level regulation, or those which must be implemented by others will receive lesser attention. At this point in the study, it is felt that the area which will be impacted the most by this constraint will be environmental studies. The studies necessary to address systemwide alternative plans such as lake level regulation, because of their very high costs, will not be possible within the context of this study. With further international studies necessary for such systemwide alternatives, the Lake Ontario Shoreline Protection Study will strive to provide at least the detail which would allow for a reasonable assessment of impacts, cognizant that more detailed studies in a future international study would be forthcoming. More importantly, the LOSPS will emphasize the identification of additional information which will be necessary during these international studies to adequately assess lake level regulation plans.

Public attitude toward the study has been and most probably will continue to constrain study efforts. In their own minds many riparians know what their problem is, its cause, and the solution. They perceive that their problems of erosion and flooding are caused by improper regulation of lake levels and changes thereto would provide the solution. Such a simplistic and singular view of the issue does not recognize other interests of the lake, its shoreline, and along the St. Lawrence River. There are many with this view who see the solution as being so evident that there is no need for this study, or that the study should address only lake level regulation. Many of these riparians are, therefore, reluctant to discuss any aspect of Lake Ontario and its shoreline apart from lake levels and their regulation. This reluctance to fully discuss problems, alternatives and impacts, especially at workshops, constrains the discussion of all issues. It is conceivable that such reluctance may be counterproductive to their interests. If impacts of other alternatives are not properly assessed, one may appear economically, socially, or environmentally better than lake level regulation, and thus, could be the recommended plan. Such views of the issues and the study are stimulated in part by misinformation which, whether by purpose or unintentionally, is dispersed by word of mouth or news articles such as editorials and newsletters. Also contributing to this reluctance is the opportunistic use of the issues, the riparians' exhilaration, and the study for political advancement by a few local officials.

5.2 COASTAL POLICIES OF THE STATE OF NEW YORK

5.2.1 COASTAL ZONE MANAGEMENT PROGRAM

The Coastal Zone Management Act of 1972, as amended (Public Law 92-583) has declared a national interest in the effective management, beneficial use, protection, and development of the coastal zone. It states that Congress finds that, "The key to more effective protection and use of the land and water resources of the coastal zone is to encourage the states to exercise their full authority over lands and waters in the coastal zone . . ." The result of New York State's involvement in the National Coastal Zone Management Program has been the draft publication of the New York State Coastal Management Program. The program is presently awaiting passage by the New York State Legislature of necessary implementing legislation prior to sending the program to Washington, DC, for its approval.

Section 307 of the CZM Act requires that Federal agencies with activities directly affecting the coastal zone or development projects within that coastal zone must assure that those activities or projects are consistent, to the maximum extent practicable, with the approved State program. Since the approval of New York State's program during the course of this study is very probable, the objectives of the study, its conduct, and results therefrom shall be consistent with and compliment the New York State Coastal Zone Management Program.

5.2.2 COASTAL POLICIES

The paramount objective of the CZM program was the establishment of policies by which New York State plans to manage, protect, and develop its coastal zone. For Lake Ontario these policies are identified relative to 10 general areas of concern. These policies are as follows:

a. Aesthetics

- Inventory aesthetic resources of Statewide significance within the coastal area;

- Preserve and protect aesthetic resources of Statewide significance within the coastal area;

- Incorporate aesthetic considerations in public and private planning and development in the coastal area;

- Increase visual access to and along the shore and protect existing points of visual access.

b. Agriculture

- Conserve all important agricultural lands in the State's coastal area.

c. Air Quality

- Land use or development in the coastal area shall not cause national or State air quality standards to be violated;

- Coastal management policies will be considered in classifying land areas pursuant to the significant deterioration regulations of the Federal Clean Air Act.

d. Economic Development

- Give locational and funding priority to water-dependent and water-enhanced economic activities;

- Channel growth within the coastal area to already developed areas;

- Expedite permitting procedures to facilitate the siting of economic activities at locations identified by the Coastal Management Program as desirable for development;

- Promote New York State's major ports as centers of commerce and industry;

- Encourage the development of harbor areas to maximize the economic and social benefits to be gained by surrounding localities;

- Encourage urban localities to undertake waterfront development projects.

e. Energy Development

- Develop an integrated and comprehensive Statewide long-range energy master plan so as to provide a framework for energy-related decisions in New York State;

- In a single proceeding, provide for the expeditious siting of major electric generating facilities, balancing the public need for electricity, the compatibility of such facilities with the environment and the necessity of a shorefront location for such facilities.

- Provide for the siting of major gas and electric transmission and associated facilities and ensure that such facilities will serve the public interest, convenience, and necessity, be compatible with the environment and if necessary, are sited at the most appropriate shorefront location;

- Provide for the siting of petroleum facilities taking under consideration: State and national energy needs; the need to minimize adverse impacts on water and air quality; and if such facilities require a shorefront location, provide this location within or adjacent to existing ports;

- Provide for the siting of liquified and substitute natural gas facilities through a review process which balances State and national energy needs, public safety concern, and the necessity for a shorefront location.

f. Fish and Wildlife

- Significant coastal fish and wildlife habitats will be preserved, managed and where possible, restored so as to maintain or reestablish their viability as habitats;

- Fish, wildlife, and their habitats shall be protected from contamination due to the introduction of toxic substances and other pollutants;

- In a manner consistent with sound resource management considerations public use of fish and wildlife resources for recreational purposes shall be expanded by increasing access to existing resources, supplementing existing stocks and developing new resources;

- In a manner consistent with sound resource management considerations, encourage increased utilization of commercial finfish and shellfish resources by expediting the construction of new or the improvement of existing commercial fishing support facilities, increasing access to fishing areas, maintaining adequate stocks and expanding aquaculture activities.

g. Flooding and Erosion

- Minimize the damage to property and to natural resources of great public benefit caused by the erosion of the coastline;

- Dredging or excavation in coastal waters should not interfere with the natural processes which supply sand to shorelands nor cause erosion of those shorelands;

- Minimize damage to property caused by the flooding of coastal lands preferably through the application of appropriate land use and performance standards and criteria, or where necessary by constructing structural flood controls provided they are determined to be technically feasible and environmentally and economically acceptable.

- Property owners along the shorelands of Lake Ontario should have direct representation on the International St. Lawrence River Board of Control;

- A study board should be appointed by the International Joint Commission, or by a United States Federal entity, to investigate and report expeditiously on ways to improve the regulation of Lake Ontario's water levels.

h. Public Access

- Consistent with natural resource protection and public demand, provide for maximum public access to public water related recreation resources and facilities;

- Increase opportunities for physical access to the coastline-at-large, consistent with natural resource protection and protection of private property rights.

- Increase visual access to and along the shore and protect existing points of visual access;

- Maintain a procedure for the identification of coastal areas requiring improved public access.

i. Recreation

- Give priority to water-related recreation over non-water-related recreation in the development of State park facilities and in the allocation of State and Federal funds for the development of recreation facilities;

- Increase the amount of coastal recreational facilities in and near urban areas;

- Give priority to acquisition of land shoreward of major transportation facilities where these have significantly reduced the amount of accessible shorefront land;

- Promote the role of the private sector in the provision of recreation facilities;

- Develop recreational marinas, public boat launching sites, and harbors of refuge where demand is greatest;

- In a manner consistent with sound resource management principles, provide for increased public use of fish and wildlife resources for recreation purposes by increasing access to existing resources, supplementing existing stocks, and by developing new resources;

- Preserve historic, cultural, and archeological resources;

- Ensure the consideration of recreation as a multiple use in the development and management of public facilities in coastal areas and in the development of waterfront property;

- Prevent incompatible development on lands immediately adjacent to recreational resources.

j. Water Quality

- Municipal, industrial and commercial discharge of pollutants, including, but not limited to, toxic substances and hazardous substances, into coastal waters shall conform to State water quality standards;

- State coastal management policies and information pertaining to specific land and water uses shall be considered while reviewing coastal water classifications and while modifying water quality standards; however, those waters already overburdened with contaminants shall be recognized as being a development constraint;

- Encourage the use of alternative or innovative sanitary waste systems in those areas where the cost of conventional facilities are unreasonably high, given the degree of protection they would afford; priority in encouraging the use of such systems shall be accorded to those areas where significant coastal resources will be protected;

- All practicable efforts shall be undertaken to control storm runoff and combined sewer overflows; priority in coastal waters for such efforts shall be accorded to those areas where protection of significant coastal resources will be protected;

- In providing funds to apply best management practices to mitigate rural nonpoint pollution problems, priority shall be given to those critical agricultural-related water quality problems which can best be eliminated or reduced through such practices. The threat of impact on significant coastal resources will also be considered;

- Discharge of waste material from vessels into coastal waters shall be limited so as to protect fish and shellfish habitats, recreational areas and water supply areas;

- Dredging and other excavation in coastal waters shall be undertaken in such a manner so as to minimize adverse effects on water quality and on other significant coastal resources;

- Spills associated with the shipment and storage of petroleum and other hazardous substances into coastal waters will be minimized; all practicable efforts shall be undertaken to expedite the cleanup of such discharges; and restitution for damages will be required when these spills occur;

- All practicable efforts shall be undertaken to minimize the discharge of excess nutrients into coastal waters from both point and nonpoint discharge sources;

- All practicable efforts shall be undertaken to insure the protection of the quantity and quality of groundwaters, particularly where such waters constitute the primary or sole source of water supply;

- The disposal of soild wastes and the construction and operation of solid waste management facilities within coastal areas shall be conducted in such a manner as not to release contaminants into ground and surface waters;

- Effluent discharged from major steam electric generating and industrial facilities into coastal waters shall not be unduly injurious to fish and wildlife and shall conform to State water quality standards.

5.3 PLANNING OBJECTIVES

Section 4.1 discusses the National Objectives relating to the planning and development of the Nation's water and related land resources. These objectives can be considered more understandably as national goals. These goals are National Economic Development (NED) and Environmental Quality (EQ). Study or planning objectives are national, State, and local water and related land resource management problems and needs specific to a given study area that can be addressed to enhance National Economic Development or Environmental Quality. Planning objectives are means of bridging the gap between the universality of the two national goals and the specificity of the problems in a given area. While it is not possible to directly plan for enhancing NED by increasing the value of the Nation's output of goods, and improving national economic efficiency, it is possible to contribute towards these needs and NED, for example, by reducing damage due to erosion and flooding along Lake Ontario. The same can be said for contributions to EQ.

The purpose of planning objectives is to provide sufficient specificity to direct the study in a meaningful manner. These objectives will be used to guide the formulation of alternative plans. They are also used in evaluation, when it is necessary to determine the degree to which each plan fulfills the requirements of each objective as a basis for reiteration. Generally, they will become more precisely defined as the study progresses through subsequent planning stages.

The planning objectives for the Lake Ontario Shoreline Protection Study have been developed in cognizance of:

- the problems, needs, and opportunities of the United States shoreline of Lake Ontario;

- the mission of the U.S. Army Corps of Engineers relative to the planning, management and development of the Nation's water and related land resources;

- the specific issues which the U.S. Congress has directed the study to address; and

- the policy initiatives which have been promulgated by the New York State Coastal Zone Management Program.

The planning objectives have been developed to address the problems, needs, and opportunities of Lake Ontario and its shoreline within a 50-year period of analysis (1990-2040).

The planning or study objectives are divided into two categories. The first are Primary Study Objectives. These objectives address the resources within the context of the purpose and intent of the study authorization; therefore, plans which are formulated must address one or more of these objectives. The second category is Secondary Objectives which address other related resources of Lake Ontario and its shoreline. These objectives will

be used to refine the formulation of alternative plans such that the plans are responsive to as many other resource problems as possible with a view to optimizing contributions to NED and EQ.

The planning objectives for the Lake Ontario Shoreline Protection Study are as follows:

5.3.1 PRIMARY PLANNING OBJECTIVES

- Promote and/or provide flood damage reduction measures to protect the health, safety, and property of people along the shoreline of Lake Ontario.

- Promote and/or provide measures which increase soil stability to protect and prevent damage to property from erosion along the shoreline of Lake Ontario.

- Provide for use and management of shorelands and tributary uplands in ways that reflect the normal process of change affecting shoreline resources in order to preserve the natural environment.

- Conserve and/or protect land forms, soils, vegetation, water, fish and wildlife which are a part of the Lake Ontario shoreline ecosystem.

5.3.2 SECONDARY PLANNING OBJECTIVES

- Enhance the availability of access sites to Lake Ontario for recreational fishing.

- Enhance the availability of access sites to Lake Ontario for use as shoreline viewing areas and protect existing sites.

- Enhance the availability of access sites to Lake Ontario for recreational boat launching.

- Provide sufficient draft for reliable access by boats to harbor areas subject to shoaling.

- Contribute to the health and safety of recreational boaters.

- Enhance the availability of beach areas available for recreational use.

- Conserve prime and important agriculture lands along Lake Ontario.

- Protect land and water areas within the coastal area of Lake Ontario for aesthetic characteristics of Statewide significance.

- Promote land and water use which maintains or improves air quality.

- Encourage the development of harbor areas for commercial and recreational navigation.

- Provide for siting of major water-based commercial, industry, and utility facilities.

- Increase the amount of coastal recreational facilities in and near urban areas.

- Contribute toward protection/preservation of cultural resources along the Lake Ontario shoreline.

- Enhance the amount of water and the head available for hydropower generation.

- Provide sufficient draft for navigation.

- Enhance the water quality of Lake Ontario for fishery purposes.

- Enhance the water quality of Lake Ontario for contact water recreation.

- Enhance the water quality of Lake Ontario for domestic consumption.

- Provide sufficient quantities of water for domestic and industrial consumption.

- Promote the utilization of Lake Ontario fish and wildlife.

- Preserve and enhance aquatic habitat for flora and fauna in Lake Ontario.

- Preserve and enhance terrestrial habitat for flora and fauna along the shoreline of Lake Ontario.

As the study progresses, these planning objectives will be continuously reanalyzed and refined as new problems and needs are identified or regional objectives change. Each plan, which is formulated in subsequent stages of the study, will be evaluated as to whether and how well it addresses these objectives.

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SECTION 6
FORMULATION OF ALTERNATIVE PLANS

LAKE ONTARIO SHORELINE PROTECTION STUDY

SECTION 6

FORMULATION OF ALTERNATIVE PLANS

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SECTION 6 - FORMULATION OF ALTERNATIVE PLANS

6.1 THE PROCESS

Congress has directed the Corps of Engineers to investigate: (1) the feasibility of protecting the United States shoreline of Lake Ontario; (2) proposals for equitable cost sharing; and (3) the feasibility of regulating the level of Lake Ontario to assure maximum protection of the natural environment and to hold shoreline damage to a minimum. To help insure that the best overall plan for each of the above is developed, a range of alternative plans will be formulated based on different sets of formulation criteria. Both structural and nonstructural solutions will be given equal consideration. The solutions considered will not be constrained by considering only those traditionally used by the Corps nor those within the Corps authority to implement. All plans presented at the conclusion of the Lake Ontario Shoreline Protection Study will be fully implementable and capable of being selected as the best overall plan, including "no action."

Using the primary planning objectives as the impetus to formulating alternative plans, plans will be formulated to address one or more of these objectives. Considering the difference in desired results required by (1) and (3) above, plans will be formulated independently for each result. Because cost sharing may be a function of the type of measure associated with a plan and, considering the number of possible solutions, cost sharing alternatives or proposals will not be formulated until Stage 3 when a more reasonable number of plans are available for analysis.

As with the other planning tasks, formulation of alternative plans is accomplished in varying degree of detail during each of the three stages of study development. During Stage 1 - Reconnaissance Study, the first step in formulating alternative plans was accomplished, that being, the identification of resource management measures relative to the primary planning objectives. A wide variety of technical and institutional means are identified which reduce erosion and flooding or reduce the damage resulting therefrom. During Stage 2, these measures are then selected for application to a specific problem area, and an alternative plan is formulated for the site specific case. Through an iterative process of problem identification, impact assessment, and evaluation, these plans are refined. In developing these plans, full consideration will be given to plans of others. Stage 3 will consider those plans which have been selected for detailed analysis and will focus on detailed formulation and impact assessment.

Principles and Standards for Planning Water and Related Land Resources (P&S), requires that, to the extent possible during the planning process, a plan which optimizes National Economic Development (NED) contributions, and

at least one plan which emphasizes Environmental Quality (EQ) contributions will be formulated. The plans which maximize and result in net positive impacts on these contributions respectively will be identified as the NED plan and EQ plan. A NED plan addresses the planning objectives in a way which maximizes net economic benefits. Recognizing that environmental quality has both natural and human manifestations, an EQ plan addresses the planning objectives in a way which emphasizes aesthetic, ecological, and cultural contributions. Beneficial EQ contributions are made by preserving, maintaining, restoring or enhancing the significant cultural and natural environmental attributes of the study area. During Stage 2, candidate NED and EQ plans will be formulated and identified with the final designation of the respective plans during Stage 3. Other plans which address mixes of NED and EQ will also be formulated so as not to overlook the "best" plan. The identification of NED and EQ plans is to provide an indication of the economic and environmental tradeoff which would result if a plan other than the NED or EQ plans were selected. Although the management option of no action or letting the "without condition" occur is not considered an EQ plan, it will be considered throughout the plan formulation process for purposes of comparison and possible selection for final recommendation. Additionally, a primarily nonstructural plan will be formulated and consideration will be given to conservation measures.

6.2 MANAGEMENT MEASURES

The following are management measures which have been identified relative to the planning objectives. The measures are technical and institutional means of effectuating a reduction of shoreline damage due to erosion and flooding. These measures are divided into two categories, structural and nonstructural measures. For purposes of definition, "nonstructural measures" are actions taken directly on land, population, or property to reduce erosion and flood damage, as contrasted to "structural measures," which are actions taken or improvements constructed to act directly on the water to change its direction, area of inundation, volume, stage or timing, or to dissipate its energy. Another way of looking at these definitions is that structural measures are active/corrective in that they are directed at the cause of the problem, whereas, nonstructural measures are passive/preventative in that they are directed at the recipient of the problem.

6.2.1 STRUCTURAL MEASURES (TRADITIONAL/ACTIVE)

a. Groins.

Groins are finger-like structures, constructed from a point landward of the shoreline to a point far enough in the water to accomplish their purpose. They are usually perpendicular to the shoreline and constructed of timber, steel, stone, concrete, or other materials. The purpose of groins is to provide or maintain a protective or recreational beach. They build or widen a beach by trapping littoral drift. Existing beaches are stabilized by reducing the rate of loss. They can be used to reduce the rate of longshore transport out of an area by reorienting the shoreline such that it is more perpendicular to the predominant wave direction. Essentially a groin is a

barrier or dam to the sand moving in the littoral zone. Acting singularly or as a system, material accumulates on the updrift side. Supply to the downdrift shore is reduced causing erosion in many cases. The resulting beach provides protection to upland areas as well as providing a recreational area. Their beneficial effects can be spread over considerable lengths of shore and, depending upon their location and hydrologic conditions including wave climate, can be constructed at a reasonable cost. Disadvantages of groins are: (1) they are not as effective as seawalls or revetments at protecting upland areas, (2) they may be outflanked and become ineffective, (3) they are ineffective in areas of low littoral drift unless artificially added; and (4) downdrift shoreline may be subjected to increased erosion.

b. Bulkheads, Seawalls, and Revetments.

Bulkheads, seawalls, and revetments differ only in their primary purpose. By definition, a bulkhead is a structure separating land and water areas. Its primary purpose is to resist soil pressures and function as a retaining wall with a secondary function of protecting the backshore from wave attack. A seawall is also a structure separating land and water areas. Its primary purpose is to protect the backshore from damage by wave action with incidental use as a retaining wall. The primary difference between bulkheads and seawalls is the degree of soil support they are designed to withstand. Finally, a revetment is a facing, generally of stone, built to protect an otherwise stable embankment against erosion from wave action.

The principal advantages attributable to bulkheads, seawalls, and revetments are: (1) they provide positive protection and generally permit more intensive use of the adjacent upland; (2) they maintain the upland area on a fixed alignment, and (3) they are adaptable to providing protection to an area with a minimum of incidental damage to adjacent areas. Disadvantages of bulkheads, seawalls, and revetments are: (1) they are not effective in maintaining a beach; (2) they provide no protection to adjacent areas which may continue to erode and eventually expose the flanks of the protected property.

c. Beach Nourishment.

This is a means of dissipating wave energy in order to keep wave action from reaching the erodible backshore. Sand is pumped or placed on a beach to widen it and flatten its profile, thereby reinforcing its natural ability to attenuate wave energy. The advantages of protection by beach fills are its pleasing appearance and possible recreational value. The principal disadvantages are that they require an adequate supply of beach material economically located, and continuous maintenance must be provided.

d. Levees and Floodwalls.

Levees are earthen embankments which are used to provide flood protection from high water caused by either short-term, seasonal, or long-term water level fluctuations. When used for protection from coastal flooding and where such use exposes the levee to the forces of waves, the levee would require armor, i.e., stone, to protect its structural integrity. Floodwalls

serve the same function as levees. It is essentially a wall constructed of concrete which acts as a barrier to flood waters. Levees and floodwalls can be used to protect an entire area or used to protect a single structure, although they become less cost effective for the latter. These structures, while providing excellent protection against flooding, may be aesthetically unpleasing in urban or developed areas, such as the Lake Ontario shoreline, because of effect on the visual panorama associated with the shoreline and its desired use.

e. Offshore Breakwaters.

These are breakwaters which are usually constructed of stone, concrete, steel or timber. They are constructed offshore and generally parallel to the shoreline. The breakwaters are designed to protect an area from wave action by intercepting the waves and their energy before it reaches the shoreline. Because there is very little wave energy between the breakwater and the shore, the littoral material being transported along the shoreline is deposited. The offshore breakwater is probably the most effective means of completely intercepting movement of littoral material. Because longshore transport is a direct result of wave action, the extent to which the breakwater intercepts the movement of littoral drift is directly proportional to the extent of wave attenuation achieved by the breakwater. As a result of this entrapment, the beach area behind the breakwater builds up. Where such entrapment is completely affected, the beach can develop to a point where it actually builds out to the breakwater forming a "Tombolo." When this happens, it effectively acts as a groin completely stopping the longshore transport. This, of course, results in accelerated erosion downdrift of the structure. The offshore breakwater provides the advantages of protection without impairing the usefulness of the existing shoreline and also creates an area of sheltered water. Conversely, the breakwaters have a high construction cost and can relocate a problem by reducing littoral transport and cause sand starvation and erosion at a downdrift area.

f. Lake Level Regulation.

Regulation is the control of the magnitude and sequence of outflows from a reservoir (lake) to effectuate a desired storage or water level. Structures such as a dam are required to provide the control. Channel enlargement may also be required during periods of low supplies to enable minimum flows and will provide additional capacity downstream during periods of very high outflows. Lake Ontario's outlet has been modified with control structures and channel alterations, thus allowing for regulation of Lake Ontario levels.

Any regulation of outflows must have a plan which reflects the past and anticipates future conditions. Historical hydrologic data and weather forecasting techniques are used for these purposes. However, since accurate long-term weather forecasting has not yet been achieved, primary emphasis is placed on historical data to devise the rules and indices that make up the regulation plan. The purpose of the rules and indices is to provide levels and flows that result in generally beneficial conditions without unacceptable adverse effects on any one interest.

Since its adoption in 1963, the current operational plan for regulation of Lake Ontario outflow has been Plan 1958-D, supplemented with the Board's discretionary authority. Plan 1958-D establishes rules which indicate the outflow to be released under operation for various conditions of lake levels and supplies. The plan utilizes rule curves and seasonal adjustments thereto to specify outflows from Lake Ontario as a function of water level and supplies to the basin. The outflows thus prescribed are then subject to certain maximum and minimum flow limitations to insure that the criteria and other requirements of the Orders of Approval are satisfied.

During Stages 2 and 3, alternative plans will be developed based upon two scenarios. The first assumes only changes to the regulation plan itself to generate an improved water level regime. Therefore, this scenario will use the existing channel capacity for the St. Lawrence River. The second assumes changes to regulation under varying increases in channel capacity. Such plans would be formulated to give varying degrees of improvement to regulation and resulting lake levels. The International Lake Erie Regulation Study is presently investigating possible capacity improvements. Those investigations should provide preliminary indications where such improvements are needed for the Lake Ontario Shoreline Protection Study. The following are some of the excavation alternatives which are being investigated for the International Section of the St. Lawrence River:

(1) Excavation from Chimney Point to Morrisburg adjacent to the navigation channel to permit a flow increase of 10,000 cfs, 20,000 cfs, and 30,000 cfs.

(2) Excavation in the Galop and Ogden Island areas located in the channels on the south side of these islands to permit a flow increase of 20,000 cfs.

(3) Excavation in the reach from Iroquois Dam to Morrisburg to allow for increased flows.

Estimated excavation quantities are as follows:

Excavation Alternative	Description of Excavation Alternative in the International Section	Total Est. Excavation Volumes (Millions of Cu. Yds.)
1	Excavation from Chimney Point to Morrisburg, adjacent to the navigation channel, and to permit a flow increase of 10,000 cfs at Lake Ontario elevations above 244.5 IGLD.	7.5
2	Excavation from Chimney Point to Morrisburg, adjacent to the navigation channel, and to permit a flow increase of 20,000 cfs at Lake Ontario elevations above 244.5 IGLD.	15.0

Estimated Excavation Quantities (Cont'd)

Excavation Alternative	Description of Excavation Alternative in the International Section	Total Est. Excavation Volumes (Millions of Cu. Yds.)
3	Excavation from Chimney Point to Morrisburg adjacent to the navigation channel, and to permit a flow increase of 30,000 cfs at Lake Ontario elevations above 244.5 IGLD.	22.0
4	Excavation and hydraulic capacity as per Alternative 2, but with channel excavation in the Galop and Ogden Island areas located in the channels on the south side of these islands rather than adjacent to the north side navigation channels	20.0
5	Excavation similar to Alternative 2, but limited to the Iroquois Dam to Morrisburg reach adjacent to the navigation channel. This will permit flow increases up to 20,000 cfs at Lake Ontario elevations above 245.7 IGLD.	4.9

Remedial works in the Canadian reach of the St. Lawrence are restricted to the Montreal area. Here, enlargement of the Lachine Rapids channel is required to mitigate flooding in Lake St. Louis that could result from increased Lake Erie and hence Lake Ontario outflows. A compensating structure at Lachine may also be necessary to offset the effect of the channel enlargement during normal and low Lake Ontario outflows. Channel excavation of up to 4.8 million cubic yards would be required. Excavation quantities for the three alternatives are as follows:

Excavation Alternative	Description of Excavation Alternative in the Lachine Rapids	Total Est. Excavation Volumes (Millions of Cu. Yds.)
1	Excavation of portion Area "A" with no compensating structure, to provide a flow increase of 20,000 cfs.	1.8
2	Excavation of Area "A" only, plus a control structure at the head of excavated channel, to provide a flow increase of 35,000 cfs.	3.3
3	Control structure and excavation of Area "A" as per Alternative 2, plus channel excavation of Area "B." This will provide a flow increase of 50,000 cfs.	4.8

6.2.2 NONSTRUCTURAL MEASURES (NONTRADITIONAL/PASSIVE)

a. Floodproofing.

Floodproofing consists of those adjustments to structures and building contents which are designed or adapted primarily to reduce flood damages. Such adjustments can be scheduled in existing buildings during remodeling or expansion, and incorporated into new buildings during initial construction. Floodproofing measures can be classified into three broad types. First, there are permanent measures which become an integral part of the structure and, in consequence, are rarely noticeable. Second, there are contingent or standby measures which are used only during floods, but which are constructed or made ready prior to any flood threat. Third, there are emergency measures which are carried out during a flood according to a predetermined plan. Floodproofing measures include such things as: (1) "clustering" buildings in planned unit developments on sites which are above flood levels, reserving low-lying flood prone areas for green areas and parking facilities, (2) using fill to raise an area out of the floodplain, (3) raising the structure and foundation, (4) flood shields, (5) using water resistent construction materials, (6) relocation of damageable property within a structure, etc. The appropriateness of floodproofing in any given region depends upon the stage of flooding, the duration of the flood period, the uses being made of the flood plain, and the relationship of floodproofing to other flood damage reduction measures. In addition to its principal values of permitting occupance in flood plains and enabling a building to function during flood periods, floodproofing has some other benefits:

(1) It offers an additional tool in a comprehensive flood damage reduction program.

(2) It can increase the protection afforded by partial protection flood control projects.

(3) It may improve the availability of flood insurance.

(4) Properly understood, it can increase interest in flood damage reduction programs by heightening the awareness of flood risk.

Floodproofing, like other methods of preventing flood damages, has limitations. It can generate a false sense of security and discourage the development of needed flood control or other actions. Indiscriminately used, it can tend to increase the uneconomical use of flood plains. Applied to structurally inadequate buildings, it can result in more damage than would occur if the building were not floodproofed. The floodproofing technique also presents certain practical difficulties. A complex pattern of land and building ownership would present problems in cooperation before a community-wide program of floodproofing could be carried out. In addition, retail businesses as well as houses frequently change ownership and this tendency would discourage investments for producing primarily long-term flood protection benefits. Another complication is the requirement of accurate and timely flood forecasts for successful floodproofing operations in some areas.

b. Public Policy Inducements (Tax Adjustments and Cost Sharing).

Shore objectives can often be satisfied by public policies that indirectly influence the way people use shore property. Major policies of this type relate to property taxes and cost sharing.

Almost all shoreland communities employ property taxes to provide funds for their services. When property taxes are tied to the best use of land under a zoning system, property owners will be induced to develop their land up to this level or sell to someone who will. If property tax levels are tied to actual use, property owners will feel less pressure to develop. To encourage special use and actions critical to a master plan, preferential tax levels can be levied and taxes can be deferred or waived. While methods such as these are employed to preserve open space or encourage conservation measures, they also encourage the speculative holding of land. For example, an owner might willingly cooperate with a plan for a green belt area around a city by keeping his land in essentially tax-free pasturage until urban development in the vicinity raises the market value of his holdings to an irresistible level. The deferment or waiver of taxes on wetlands may not have a great inducement effect since wetlands are usually taxed at a very low rate. Taxes can also be used in conjunction with a special protection district which would have legislative authority to provide protective measures along its shoreline and tax those protected for such cost.

Cost sharing can be a very effective inducement to meet some shore objectives. Three principles of cost sharing are widespread benefits, indivisibilities, and user charges. When the benefits of a proposed action, such as beach acquisition or public development, are judged to be sufficiently widespread, higher levels of Government often recognize a responsibility to share the cost under various formulas. When benefits can be pinpointed, user charges should be considered, but the administrative cost of collecting these charges often eats up most of the revenues gained. In return for sharing the cost, higher levels of Government frequently exact binding agreements to assure that the benefits are indeed widespread. Federal contribution to shore protection projects is heavily influenced by the degree of public access and use.

c. Purchase/Easement.

These measures involve the acquisition of title or rights of land within the Coastal Zone. These measures would be applied to undeveloped land which, because of development pressures, have a high likelihood of development in the future. The lands would probably be wetlands or areas of special significance such as dune areas.

Lands may be obtained by fee title. Fee title is an absolute ownership of property. Legally, no private property may be taken for public purpose without the payment of just compensation. The courts have held that just compensation means the fair market value of the property rights taken, plus

damages, if any, to the remaining property. Land obtained in fee title for public purposes may be secured either by negotiation or condemnation proceedings.

Land may be acquired through private negotiation between the sponsors and the land owner. Such proceedings are normally on the base of a willing buyer and unwilling seller. However, a price may be set by negotiation that is satisfactory to the seller, or at least he may assume that he will be better off than what he would be if he went through court action.

The right of eminent domain is the power belonging to the Government to take private property for public use without the consent of the owner. Many local organizations, when unable to obtain land rights by negotiation have the authority to institute condemnation proceedings. The determination of just compensation is generally made by a jury, though sometimes by agreement of the parties involved, or by the court itself.

Easements are distinguished from fee title as they do not transfer ownership. An easement is any of several rights which one may have over another's land. Easements also may be secured by negotiation or condemnation proceedings. The following principles apply to easements: (1) easements are fractional property rights; (2) easements involve the transfer of something less than all of the rights inherent in absolute fee ownership; (3) Due to the limited conveyance of rights, it is possible for more than one easement to be granted on the same tract of land, provided the rights previously granted are not duplicated or interfered with.

d. Evacuation/Relocation.

During an emergency when wave action or flood waters present a threat to life and limb, evacuation procedures are implemented. These involve the temporary movement of people to land areas that are relatively safe from erosion or flooding problems. In contrast, relocation involves the permanent movement of peoples, residences, business, or industry (not necessarily structures) to land areas that are relatively safe from erosion or flooding problems. This usually requires just property and/or financial compensation as a minimum requirement. Relocation is an effective alternative in lightly developed problem areas where the cost and adverse impacts of such measures are determined to be less than those for protective measures.

e. Flood/Erosion Insurance.

The National Flood Insurance Program was first established through passage of Federal legislation entitled the National Flood Insurance Act of 1968. The purpose of this program is to provide better protection to the public and to reduce annual disaster assistance outlays through the increased availability of flood insurance. Insurance by definition is economically inefficient because it reimburses for loss, but does not normally prevent the loss. Under the National Flood Insurance Program (PL 90-448, as amended) insurance is subsidized, up to an amount specified, on properties in areas designated as hazardous by the Federal Insurance Administration. The land use control measures required of communities to gain and maintain eligibility

for flood insurance are complementary to other flood plain management efforts. One aspect of the program provides for the purchase and removal of structures sustaining high and repeated damage, thus removing them from the flood plain. Another aspect of the program deals with future development by requiring participating local governments to regulate development within flood hazard areas. Section 202 of Public Law 93-234 states that no Federal officer or agency shall approve any financial assistance for acquisition or construction purposes after 1 July 1975 for use in any area identified by the Federal Emergency Management Agency as an area having special flood hazards unless the community in which such areas are situated is then participating in the National Flood Insurance Program. It is considered that this prohibition does not apply to flood related activities of the Corps of Engineers.

Presently, there is no program for erosion insurance, other than flood-related erosion. Flood-related erosion as defined by the National Flood Insurance Act is as follows:

> "Flood-related erosion" means the collapse or subsidence of land along the shore of a lake or other body of water as a result of undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as a flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding.

Coverage is only for structures damaged due to the erosion and not for the land itself.

f. Land Management.

Land management measures are another class of techniques which address shoreline erosion and flooding by influencing people in their use of the land along the shore. These measures are directed more towards future, although some are applicable to existing land use. Each is unique and, therefore, has its own capabilities and impacts. Because of their nature, they may be constrained by the institutional/legal framework within an area, and the authority provided by the implementing governmental body. The following are some of the measures which fit into the framework of land management techniques:

- Zoning. By-laws generally establish zoning districts and impose restrictions on uses of land, densities, building heights, industrial development and the like. The concept is to control private property uses that may affect the community adversely. The coverage of zoning has been increasing in recent years and includes such things as:

  (1) Requirements for large enough lots for water supply and sewage disposal.

(2) Requirements for setback lines or established survey lines indicating the limits for certain types of development. These are established relative to shoreline erosion rates and/or defined flood plain, and types of future developments shoreward of these boundaries are restricted generally through State and/or local regulation.

(3) Conservancy districts - applicable to wetlands and areas subject to frequent flooding.

(4) Historic districts with special review for changes in the appearance of buildings.

(5) Port and harbor districts.

The zoning authorities have also been experimenting to cover new techniques such as:

(1) Direct open space zoning which might include conservation districts and dedicated lands, and

(2) Possible zoning of water areas for uses such as boating and swimming.

Limitations in zoning as a technique result primarily from its usually local character which severely restricts the possible impact both spatially and temporally. This deficiency could be minimized by keying the zoning to broad master plans and by State assumption of shoreland zoning aspects that have widespread implications. A zoning plan can also be made stronger with acquisition of some land use rights at key points on the shore to reduce pressure to alter the zoning pattern. Another limitation on zoning is found in judicial interpretations as to what constitutes a valid exercise of the police power. For example, in many States, zoning for purely aesthetic purposes has been judged not to be legally included by itself in the "general welfare." Aesthetic purposes are frequently upheld, however, if they can be demonstrated to contribute to the health, safety, morals, or general welfare. The protection of private property is usually found to be in the general welfare. In some States, encouragement of tourism has also been considered to be in the public welfare.

- Subdivision Regulation. Shoreland subdivisions can be required to initiate and maintain provisions for protection of the shore in areas where erosion or storm damage are probable. In addition, requirements may be made as to parks and roads and for the reservation of open shore lands for later purchase by the public. This method has less coverage than zoning as it is restricted to areas to be subdivided.

- Building Codes. Whereas zoning and subdivision regulations determine the location and some characteristics of permissible

structures, building codes deal directly with the construction considerations. In shore areas, some major concerns of building codes should be: adequacy of soils for construction and waste disposal systems, quality of construction necessary to withstand wave and wind damage or tidal flooding, assurance the structures will not adversely alter erosion patterns, and minimum elevations for fill placement. The development of an all-encompassing model shore building code is limited by the varied nature of the shore and the recognition that some buildings are already located in exposed locations and that others must be located there to fulfill their function.

- Ordinances. In the absence of State regulations or to supplement them, local governments may pass ordinances to create their own zoning or building codes or to insure consideration of problems not covered by these tools. Ordinances can deal with such things as dune protection, beach safety, tidal inundation, camping on the beach, parking, and litter control.

- Permits. Where it is not feasible to define usage controls adequately, i.e., where on-the-spot inspection is required or where site conditions may govern, permits may be required. In these instances, a proponent of a development or a land use modification must obtain the approval of a legally designated agent of government. The agent is empowered to hear the facts of the case and to make the decision usually based upon defined criteria and requirements for public notice and intergovernmental coordination. Insofar as modifications to physical shore conditions are concerned, the most significant example of permits is the permit authority of the U. S. Army Corps of Engineers governing the approval of any construction or other actions which affect navigable waters. Stemming orginally from the Federal authority over navigation, this authority has been broadened considerably by subsequent administrative interpretation and court decision to include aesthetics, fish and wildlife, and the general public welfare. In administering this authority the Corps encourages the State to review applications and indicate a position pertaining to fish and wildlife aspects. The Corps also conducts public hearings where warranted, and coordinates with all appropriate Federal agencies.

  To improve the quality of the more complex permit decisions that must be made, the Corps has consistently advocated strong comprehensive coastal planning particularly at the State level. In fact, the Corps now administers a permit system that, in conjunction with other agencies, monitors discharges into navigable waters for water quality control purposes.

- Orders. These are specific demands for an owner or community to comply with an administrative decision interpreting a broader authority. An order may restrict the owner from performing

many actions. The owner then has an opportunity to object if he considers it excessive or a taking, and may be entitled to compensation under some of these circumstances.

g. Vegetation.

Lakeshore slope surface degradation by rain and wind can be reduced using vegetation, which in conjunction with structural controls can provide a more complete solution to a specific shoreline erosion problem than structural measures alone. Some of the ways in which vegetation improves shore stability are that it: (1) may provide a favorable habitat for the establishment of deeper rooted shrubs and trees; (2) has roots that hold soil particles in place while deeper roots of woody vegetation prevent slipping of soil layers; (3) removes water from bluff areas through uptake and transpiration; (4) slows runoff and acts as a filter to catch sediment; (5) slows wind velocity and traps windblown sediment; (6) absorbs the energy of falling rain; (7) helps to maintain absorptive capacity of the soil, and (8) can reduce frost action. Other benefits of vegetation are that it can improve the visual quality of the shoreline area and provide a habitat for wildlife.

While vegetation can accomplish a great deal in the way of slope stabilization, there are limits to its use which must be realized. Vegetation alone cannot control deep seated movement of the bluff due to groundwater action. Adequate drainage control is necessary to relieve internal stresses and to handle large volumes of surface runoff during storms. Slope vegetation generally does not control wave action. It may decrease the rate at which the beach or bluff is eroded during a storm, but it cannot stop wave action. However, in wetland areas process-oriented experiments reveal that wave attenuation does occur as waves pass over the wetland's vegetation. The energy of waves is derived from winds blowing across a water surface. As the fetch or area of open water increases, so does the height of the waves. The significance of wave height is that it is related to wave energy. Another factor related to wave energy and unique to Great Lakes Coastal Zones is the changing water levels. During higher water level conditions, the wave energy is stored until the wave is nearer to the shoreline before breaking and expending its energy. Also, the vegetation density is lower with the higher lake levels which also encourages the higher wave energies to be maintained. Such conditions encourage erosional activity. Hence, the occurrence of nearshore wetlands does not seem to provide an effective buffer against coastal recession, unless lake levels could be more rigoruously regulated.

6.3 FORMULATION AND EVALUATION CRITERIA

Policy for multiobjective planning, derived from legislative and executive authorities, establishes, and defines the national objectives for water resources planning, these being National Economic Development (NED) and Environmental Quality (EQ). It also specifies the range of impacts that must be assessed, and sets forth the conditions and criteria which must be applied when evaluating plans. Plans must be formulated with due regard to benefits and costs, both tangible and intangible, and effects on the ecology and social well-being of the region.

The study planning process uses a framework established in compliance with the Water Resource Council's Principles and Standards for Planning Water and Related Land Resources, which requires the systematic preparation and evaluation of alternative solutions to problems, under the objectives of National Economic Development (NED) and Environmental Quality (EQ). This process requires that the impacts of a proposed action be measured and the results displayed or accounted for in terms of contributions to four accounts: NED, EQ, Regional Development (RD), and Social Well-Being (SWB).

The formulation and evaluation of a plan, including the screening of alternatives, must of necessity be within the context of an appropriate set of formulation and evaluation criteria. These criteria were developed to set forth the specific constraints and parameters which bear directly upon the formulation of plans.

6.3.1 TECHNICAL CRITERIA

. Alternative plans must be engineeringly feasible, practicable, and sound.

. A coincident 200-year design frequency, using the recurrent significant deep water wave height in combination with the lake level will be used for design of structures.

. Plans will be adequate to provide a project life of 50 years.

. Existing facilities will be utilized to the maximum extent possible.

. Plans will be consistent with the New York State Coastal Zone Management Program.

6.3.2 ECONOMIC CRITERIA

. Benefits will be derived from a comparison of the projected "without-project" conditions to the projected "with-project" conditions.

. The total beneficial contributions (monetary and nonmonetary) exceed the total adverse contributions (monetary and nonmonetary).

. Tangible NED benefits must exceed project costs unless the deficiency is the result of NED benefits foregone or costs incurred to obtain positive EQ contributions.

. Each separable unit of improvement must provide benefits at least equal to its cost.

. Plans should contribute to an equitable land taxing structure.

. There is no more economical means, evaluated on a comparable basis of accomplishing the same purpose or purposes which would be precluded from development if the plan were undertaken.

- Intangible benefits will be evaluated in quantified terms, where possible.

- The costs for alternative plans will be based on preliminary layouts, estimates of quantities, and price levels current at that time.

- Benefits and costs should be in comparable economic terms to the fullest extent possible.

- Economic analysis will be conducted utilizing the current interest rate determined by the Water Resources Council and a period of analysis of 50 years.

6.3.3 <u>ENVIRONMENTAL AND OTHER CRITERIA</u>

- The use of natural resources to effect implementation of a plan will be minimized.

- Activities attracted to the project area after plan implementation should be consonant with activities of the surrounding area, and be environmentally and socially acceptable.

- Plans should maximize the beneficial and minimize the adverse effects of the project on man-made resources, natural resources, and air, water, and land pollution.

- Plans should avoid detrimental environmental effects to the extent feasible. Unavoidable adverse environmental impacts should be fully noted, analyzed quantitatively when possible and qualitatively when not, so that knowledgeable decision making would be possible and feasible mitigating features for such effects can be included.

- A plan is acceptable only if it is supported by some significant segment of the public. Every attempt will be made to eliminate, to the extent possible, unacceptability to any significant segment of the public.

- Plans should minimize and, if possible, avoid destruction or disruption of community cohesion, injurious displacement of people, and disruption of desirable community growth.

- Plans will protect and enhance the scenic and aesthetic resources, when possible.

6.4 PLAN FORMULATION RATIONALE

Having identified the management measures and objectives of the study, the rationale or methodology which will be used to formulate alternative plans during Stages 2 and 3 will be one which uses the iterative process discussed in Section 6.1. By repeated and more refined analysis of the problems and needs, and assessment of impacts, feedback is provided to the formulation of plans such that contributions to NED and EQ are optimized in

addressing a broad range of planning objectives. For a specific problem area, plans will be formulated to address a single primary planning objective with a view to combining compatible measures to address a number of primary and secondary measures. Through impact assessment and evaluation of objective fulfillment, those objectives that have not been or are partially addressed will be identified for subsequent iterations.

Plans will be optimized for their contribution to NED and EQ. A plan which optimizes the contribution to NED and EQ respectively will be identified as the NED plan and the EQ plan. Plans will also be formulated in between, demonstrating various degrees of tradeoff between NED and EQ. This is necessary because of the noncomparable units for measuring NED and EQ benefits. The optimal plan will be the plan that, whether by subjective tradeoff analysis or by sophisticated optimization model, provides the optimal or best contributions to both national goals. If a definable interrelationship cannot be made between the units of benefit/disbenefit following detailed studies during Stages 2 and 3, as most probably will be the case, the subjective approach will be used.

Lake level regulation will be considered with a view to providing a "best" plan for shoreline protection with consideration given to all interests involved, i.e. power, navigation, recreation, riparian, and the environment, and a "best" plan for the riparian and environment only. The latter is in compliance with the study authority. The analysis of lake level regulation will be accomplished utilizing the following scenarios:

- The present outlet capacity of the St. Lawrence River, and the existing Orders of Approval of the IJC.
- The present outlet capacity of the St. Lawrence River, and changes to the Orders of Approval.
- Modifications to the outlet capacity of the St. Lawrence River, and the existing Orders of Approval.
- Modifications to the outlet capacity of the St. Lawrence River, and changes to the Orders of Approval.

6.5 PLANS OF OTHERS

Public input into the formulation of alternative plans during Stage 1 consisted mainly of input during a series of workshops held during August 1979. Although the focus of those workshops was problem identification, some alternatives were offered. Alternatives offered included a joint U. S./ Canada widening or diking of sections of the St. Lawrence River in order to lower levels on Lake Ontario. Alternate outlets for the Great Lakes, such as diversion of water to the Mississippi and Hudson Rivers, were proposed. Hydrodynamic breakwaters about 2,000 feet offshore were proposed to check erosion and provide a means of harnessing the wave energy for producing electricity. Protection of local headlands as a means of stabilizing the shoreline was thought to be worthwhile. Structural protection using concrete V structures such as on Lake Michigan, automobiles encased in concrete, tires tied together, and jetties were also proposed.

Consideration of lake level regulation followed along the general theme of lowering the lakes. This included keeping the levels in the lower level of the permissible range (242.8-246.8), lowering the levels in late winter to avoid spring high levels, releasing the maximum amount of water in spring and summer, regulating the lake to its lowest level by 15 December; lowering the level on 15 June by 6 inches, dropping the level of the lake by 1 foot, and regulating to the mean of the permissible level (244.8). Attention to lake level plans also included forecasting precipitation and upper lake levels more accurately.

Nonstructural plans were also popular. These included better definition and broader coverage under the National Flood Insurance Program, the use of erosion hazard insurance, relocation of residents away from the shoreline, control of all terrain vehicles on dunes and beaches, and use of vegetation for dune stabilization. Restrictions on land use and its management was also proposed. Plans included restrictions on the sale of property to other uses and providing right-of-first-refusal for governmental bodies. There should be no building in erosion areas or in wetlands. Zoning and building codes could be used to restrict land use. Control of projects and activities that contribute to shore erosion were also proposed. Provision of additional public access would control land use and damages. Outright purchase and development rights for public ownership was suggested. Purchase of property as it comes on the market would also be a means of acquiring land for public ownership.

6.6 DEVELOPMENT OF ALTERNATIVE PLANS

6.6.1 STRUCTURAL RECOMMENDATIONS

During Stage 1, the formulation of alternative plans was generally limited to the identification of measures, with the exception of a preliminary evaluation of some structural measures. This preliminary evaluation or screening was undertaken to:

. determine if structural protection of the shoreline was economically viable;

. qualify the nature of erosion and flooding problems of the shoreline; and

. reduce the number of areas to be investigated in more detail during Stage 2.

The general philosophy of this exercise was to use the least cost method of structurally protecting each of the erosion and floodprone areas identified in Sections 4.4.1 and 4.4.2. Thus, if, by using the least cost method of structural protection, being conservative in estimating the cost of protection and liberal on the estimated benefits, an area was not economically feasible to protect, it definitely would not be in subsequent stages of the study when the analysis becomes more stringent.

The selection of the best structure for each area was determined based upon its application for flood or erosion control, or both, the property elevation, the design lake level, nearshore slope, present protection, and shoreline condition. The design levels were based upon a 200-year occurrence for areas exposed to wave attack and 50-year for sheltered areas. The 200-year event is a combination of a 200-year lake level and a breaking wave at the proposed structure toe. These values were derived from the Report on Great Lakes Open-Coast Flood Levels by the Corps of Engineers, Detroit District, 1977, and profile data obtained as part of the reconnaissance level baseline studies. T. R. H-76-1 - Design Wave Information for the Great Lakes, Report 2, Lake Ontario by D. T. Resio and C. L. Vincent, 1976 was consulted to determine that a breaking wave was feasible for all sites. The most commonly recommended structure was the basic revetment. Seawalls in combination with revetments were recommended where property elevations were less than the minimum design crest elevation. The recommended plan of protection also took into account continuity of design within a community or hamlet. Present shoreline practices within an area were also considered in the development of the protection for an area.

6.6.2 ECONOMIC EVALUATION

The evaluation of the economic viability of structural shoreline protection was based upon the cost of the protection, the damages prevented, and additional recreational value which would be provided or loss prevented. The analysis used a 50-year project life and an interest rate of 7-1/8 percent. All assumptions were directed towards maximizing benefits. In conjunction with least costs of protection would yield an overstated BCR which was felt to be necessary for this preliminary evaluation.

Erosion damages were determined for each area using both the short-term and long-term rates, setback distance of the development, and the market value of the land and development. The benefit realized from protecting against erosion was obtained from the annual depreciation of the market value of the land and residence or business due to the loss of the land. A linear regression slope, which was obtained from the ratio of the setback distance to the average rate of erosion, was used to compute yearly depreciation. The basic assumption in this calculation was that the market value of the residence became zero when the shoreline reaches the house. The market value of the land would reduce to one-half of its original value when the shoreline reached the house.

Flood damages were derived from stage/damage curves which were developed for each of the flood prone areas during "Operation Foresight." These curves were updated to 1979 prices and to reflect any subsequent construction. For those areas not included in the "Operation Foresight" analysis, new curves were developed utilizing first floor elevations, and the value and type of structure. Damages reflected flood frequencies as reflected in Report on Great Lakes Open-Coast Flood Levels, prepared by the U.S. Corps of Engineers, Detroit District, in February 1977. In addition to damages caused by water levels, this analysis also included damages due to flooding by wave "run up." Curves assumed pre-"Operation Foresight" shoreline, i.e., no "Operation Foresight" protection.

Recreation benefits were also included based on the assumption that erosion causes a loss in beach area and that loss in turn results in a loss of recreation. It was assumed that each beach considered was presently at full capacity, therefore, the area of beach lost over time resulted in a proportionate loss of recreation. Using visitor values obtained from NYSOPR and using a value of $1.50 per visitor-day, the loss of recreational value was determined.

Table 6.1 provides the results of this analysis using both short-term and long-term erosion rates.

Table 6.1 - Economic Evaluation

Reach	Area	Recommended Protection	Benefit/Cost Ratio Short-Term Rates	Benefit/Cost Ratio Long-Term Rates
4	Harrison Grove	R	0.57	0.14
5	Uneeda Beach	R	0.43	0.49
5	Hopkins Beach	R	0.43	0.43
6/7	Sunset Beach	R	0.86	1.21
8	Tuscarora Beach	R	0.87	1.79
10	Unnamed Community	R	0.25	0.54
10	Unnamed Community (W)	R	0.27	0.56
12	Olcott & Olcott Harbor	R	4.80	4.72
15	Natural	R	4.52	4.61
16	Unnamed Community	S	0.04	0.21
20	Natural	R	0.29	0.27
20/21	Lakeside	R	8.04	8.03
22	Point Breeze	R	0.66	0.46
22	Jones Beach	R	1.95	1.75
22/23	Lomond Shore	S	0.26	0.25
26	Natural	S	0.14	0.24
28	Newco Beach	R	2.83	3.13
28	Oneto Beach	R	0.17	0.51
28	Brockport Filtration Plant	R	0.43	0.75
28	Sandy Creek	R	1.31	1.61
28	Sandy Harbor	R	0.27	0.61
28	Sandy Harbor Beach	R	0.17	0.51
29	Benedict Beach	EB,S	0.17	0.19
30	Shore Acres	S	0.20	0.30
31	Wautoma Beach/Summer Haven	R	1.12	1.88
32	Wautoma Beach/Wautoma (E)	D,FP,Reloc	0.44	0.47
32/33	Hilton Beach	R	1.34	1.58
34	Davidson Beach (W&E)	R	0.44	0.37
35	Lighthouse Beach (W)	R	0.50	0.43
36	Lighthouse Beach (E)	R	0.10	0.11
36	Bogus Point (W&E)	S	2.20	2.20
36a	Payne Beach	R	1.45	1.84
37	West Manitou Beach	R,EB,Reloc	0.29	0.62

Table 6.1 - Economic Evaluation (Cont'd)

Reach	Area	Recommended Protection	Benefit/Cost Ratio Short-Term Rates	Benefit/Cost Ratio Long-Term Rates
38	East Manitou Beach	R,EB,Reloc	1.28	1.72
38	Braddock Heights	R	5.90	6.33
38	Braddock Heights Bay	R	0.82	1.24
38	Cranberry Pond (E&W)	R	0.95	1.41
38	Grandview Beach	R	5.20	5.67
38	Long Pond (W)	R	1.29	1.71
38	Long Pond (E)	R	1.49	1.91
38	Salmon Creek	R	0.73	1.11
39	Crescent Beach	R	1.75	2.88
40	Island Cottage Beach	R	4.17	10.91
45a	Oklahoma Beach	R	2.18	2.18
46	Forest Lawn	R	0.36	0.26
49	Nine Mile Point	R	0.59	0.56
52	Ontario-on-the-Lake	R	0.24	0.23
52	Unnamed Community	R	0.24	0.23
55	Holland Cove	R	1.5	1.73
55	Pultneyville	R	0.72	0.95
58/59	Sodus Point	R,EB/R	0.32	0.18
59/68	Sodus Bay	S/R	0.18	0.24
69	Charles Point	S	0.01	0.01
84	Moon Beach	R	0.08	0.14
88	Camp Oswego	R	1.64	2.80
88	Lakeview	R	1.47	2.51
89	Shore Oaks	EB/R	0.17	0.11
89	Dempster Beach	R	0.19	0.13
90	Mexico-Mexico Point	R	0.42	0.71
91	Ramona Beach	R	0.72	0.82
91	Salmon River Inlet	R	0.06	0.14
91/92	Selkirk Beach	R	9.47	9.50
93	Rainbow Shores	R	0.08	0.08
94/95	Green Point	R	0.03	0.03
96	Montario Point	EB/R	0.19	0.21
96	Jefferson Park	EB/R	0.73	0.75
99	Boomer Cove	EB/R	0.41	0.41
99	Ray Bay	D,Reloc	0.28	0.28
105/106	Boulton Beach	R	1.16	1.16
109/110	Sherwin Bay	R	0.04	0.04

Explanation of Codes for Recommended Protection:

R = Revetment
S = Seawall
EB = Earth Berm
D = Dikes
FP = Floodproofing
Reloc = Relocation
EB/R = Combination Earth Berm and Revetment

The screening out of areas which are not feasible (B/C <1), was not possible during this analysis as had been anticipated. This was due to some of the simplifying assumptions which had to be made during the analysis. During the early part of Stage 2, the sensitivity of these assumptions will be analyzed, and if needed, the necessary data will be detailed to permit the screening.

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SECTION 7

ASSESSMENT AND EVALUATION OF MANAGEMENT MEASURES

LAKE ONTARIO SHORELINE PROTECTION STUDY

SECTION 7

ASSESSMENT AND EVALUATION OF MANAGEMENT MEASURES

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SECTION 7 - ASSESSMENT AND EVALUATION OF MANAGEMENT MEASURES

7.1 THE SELECTION PROCESS

The selection process is accomplished through the completion of two primary tasks. These tasks are "Impact Assessment" and "Evaluation." The tasks are carried out initially for all alternatives which address one or more of the planning objectives. This process is then repeated in more detail in subsequent planning stages, to again select the best of the remaining plans. This iterative impact assessment and evaluation process is continued until a single best plan is selected. One of the results of each iteration is the determination of the type and depth of further studies required to continue the selection process.

As a general guide, impact assessment involves the identification, description, and, if possible, measurement of the effects of the different alternative plans on the base year condition. Impact assessment provides for analyzing the significant effects of each alternative. These are the economic, social, and environmental consequences of an alternative which would be likely to have a material bearing on the decision-making process. Impact assessment requires forecasting where and when significant primary and higher order effects could result from implementing a given alternative. This determination requires analyzing and displaying monetary and nonmonetary changes in an objective manner based on professional and technical assessment of the resources. The absence of change or no net change from the base condition could also be a significant impact in certain instances. Describing impacts does not necessarily reflect societal preferences; such preferences are determined through subsequent coordination and evaluation with Federal, State, Regional, and local agencies and citizen interests.

Evaluation is the analysis of each plan's impacts against the "without condition" and against the other plans. Whereas impacts are identified through an objective undertaking largely on professional analysis, evaluation determines the subjective value of these changes. This is accomplished by conducting "with and without" analysis of the alternative plans and ascribing values to the impacts based on the public's perceptions of them. The process begins by establishing the contributions of each alternative in relation to the planning objectives and the economic development of the nation and region, the social well-being of the area, and the environment. Then the response to the alternatives to specified evaluation criteria is determined. From this information, judgments will be made concerning the beneficial and adverse nature of the contributions of an alternative to establish its overall desirability. After this has been done for each alternative, plans that do not result in an improvement over the

"without" condition will eventually be eliminated from further consideration. The relative merits of each remaining alternative in comparison with the other remaining alternatives will then be established. By so doing, evaluation will surface information which will be incorporated in succeeding iterations so as to more fully achieve beneficial contributions while reducing adverse contributions.

The selection process, described in the above paragraphs, forms the basis for selecting one of the detailed plans, and, if appropriate, recommending it for implementation. Plan selection is the designation of that alternative considered to be the most desirable, based on the results of this study.

The selected plan will be in the best public interest based on the public response to the detailed plans carried through the final stage. This response will include the views of those who participated in the study. The product of evaluation will be presented as a basis for public inputs to plan selection.

7.2 CRITERIA FOR IMPACT ASSESSMENT

The following is a listing of criteria preliminarily assessed in this report. Criteria marked by an asterisk (*) are specifically mentioned in Section 122 of Public Law 91-611 (Second Session, 91st Congress):

7.2.1 SOCIAL CRITERIA (Human Environment)

Population Density
Population Mobility
Housing
*Displacement of People
Transportation
*Desirable Community Growth
*Aesthetic Values
Institutional Dynamics
Health & Safety
*Community Cohesion
*Noise
Leisure & Recreational Opportunities

7.2.2 CULTURAL AND BIOLOGICAL CRITERIA (Archaeological, Historical, and Architectural *Man-Made Resources; Natural Environment)

a. Cultural Resources.

Archaeological Sites
Historical and Architecturally Significant Structures
Submerged Cultural Resources

*b. Natural Resources.

Wetlands
Fisheries
Wildlife
Threatened or Endangered Species
Benthos
Littoral Zone
Vegetation
*Air Quality
*Water Quality
Nekton and Plankton
Terrestrial Soils and Bottom Substrate
Topography
Federal - State-Owned Natural Areas (Existing)

7.2.3 OTHER ENVIRONMENTAL CRITERIA

Erosion
Sedimentation
Water Levels and Flows
Productivity

7.2.4 ECONOMIC CRITERIA

*Revenues
*Property Values
*Public Facilities
*Public Services
*Regional Growth
*Employment/Labor Force
*Business and Industrial Activity
*Displacement of Farms

7.3 IMPACT ASSESSMENT

This initial assessment is an early attempt to assess and evaluate potential alternative measures. At this first stage in the planning process, the assessment is based on existing available information. The objective at this point is to preliminarily identify potential impacts of measures, relative to basic and/or general social, biological, and economic criteria. The intent is to have identified impacts aid planners throughout all of the planning process by providing them with a tool to help them eventually select a plan that best solves the shoreline problems and best satisfies overall social, economic, engineering, cultural, and environmental concerns. As the study progresses, additional alternatives and/or criteria may be added and a more comprehensive social, economic, cultural, and environmental assessment will be developed.

7.3.1 GROINS

a. Social Criteria.

(1) Population Density

- This measure would provide increased erosion protection to uplands along the shoreline by contributing toward induced beach formation.
- Such a structure would probably induce or protect beach type development.
- With shoreline protection and increased development, population density would probably increase.

(2) Population Mobility

- Groins require construction-maintenance that may induce development, which could promote and/or provide opportunity for population movement into or near coastal zone.

(3) Housing

- Induced development stimulated by shoreline protection could provide opportunity for development of new residential housing, expansion of existing housing and/or alternate types of developments.

(4) Displacement of People

- Protection provided by this measure would help maintain or increase existing shoreland area. If needed, displacement of some people may be necessary in acquisition of shoreland area necessary for structure construction.

(5) Transportation

- If induced development occurs due to protection provided, it could in turn promote some expansion in shoreline transportation facilities.

(6) Desirable Community Growth

- The structure would probably protect and/or induce beach type development and activity.
- If increased development occurs, it would probably promote a need for additional community services and facilities to accommodate growth.

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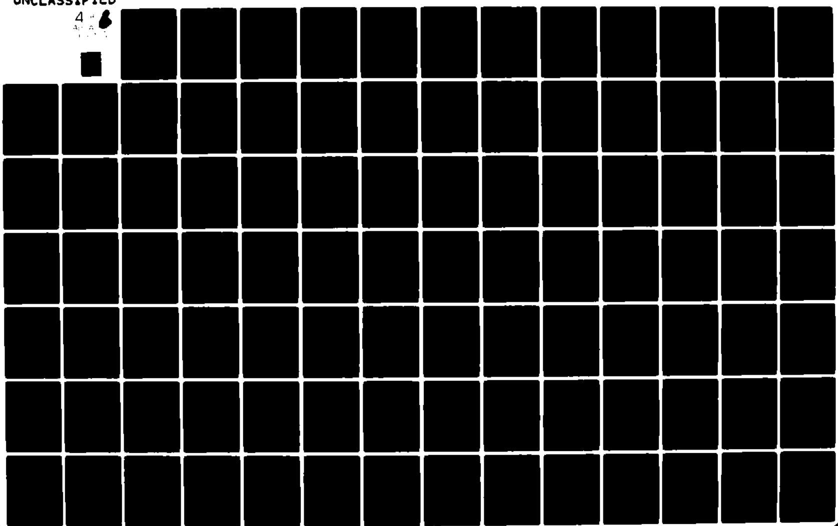

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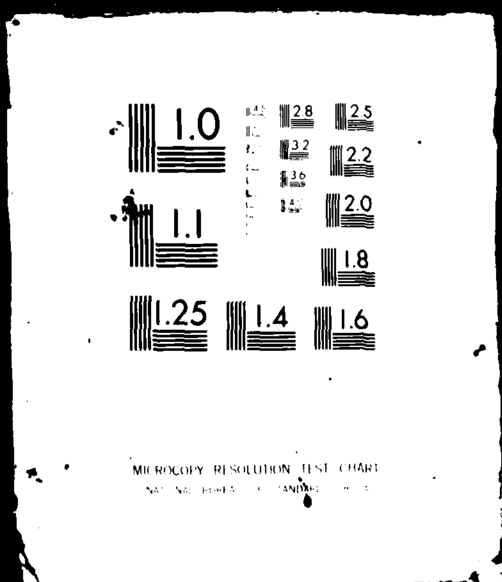

- Depending on community goals and values, any induced developments, if they occur, could be beneficial or adverse.

- Shoreline protection provided by this measure may generate a local need for management and policies regulating future coastal developments.

- Could disrupt function of existing adjacent facilitative and/or protective structures (containment of sediments-erosion down littoral drift; sediment to intakes, current dispersion of waste).

(7) Aesthetic Values

- The structure itself may be considered aesthetically unpleasing by some people whereas, beach areas created by the influence of groins may be aesthetically pleasing to others.

- It would alter the present shoreline setting.

(8) Institutional Dynamics

- Project development and maintenance would require time and effort relative to inter-organizational coordination and cooperation.

- Potential for induced developments may strengthen views of various interests concerned about shoreline use. Additionally, relative to future developments, there may be a need for alternative management, planning and facilitative measures. Groin installation could help alleviate some easement/property ownership problems to some extent.

(9) Health & Safety

- Groins would provide increased protection against erosion in the vicinity of the structure location, but it may induce erosion down-drift.

- Induced coastal zone development influenced by erosion rate retardation due to groins, may subject the associated increased population to shoreline hazards.

- Groins could be hazardous to walk on and to inshore boating recreationists.

- Property owners along the shoreline may feel a sense of increased security by the long-term protection provided by groins.

- Groins would reduce wave energy and could alter inshore currents.

- Groins could provide possible habitat for rodents.

- Groins could indirectly contribute to water stagnation by creating a ponding or calmer water zone along the immediate shoreline; such zones could also help concentrate pathogenic organisms and pollutants from nearby pollution sources.

(10) Community Cohesion

- Provided protection could indirectly contribute toward strengthening community cohesion.

- Groins may induce conflict relative to protection needs, cost, and future development interests.

- The construction process, resulting structure and altered shoreline characteristics may impact upon normal community function, thus effecting community cohesion.

- Shoreline protection in one area may create or shift problems to another area.

(11) Noise

- Installation of groins would cause temporary noise during construction and maintenance periods.

- Wave action noise would be associated with the installed structure.

- Any shoreline development induced by groin protection of the shoreline could have associated noise from human activity.

(12) Leisure, Cultural, and Recreational Opportunities

- This measure may be inducive to beach development and associated activities.

- Provided groin protection and resulting beach creation could induce possible new or expanded park or beach development.

- Such structures may provide possible fishing and/or shoreline access.

b. Cultural Criteria.

(1) Archaeological Sites

- Sites located immediately downdrift of the groin may be subject to increased erosion.

- Sites located in area of structure placement may be disturbed by ground preparation and construction.

- Sites located in the area protected by the structure may be preserved.

(2) Historical and Architecturally Significant Structures

- Sites immediately downdrift of the groin may be subjected to increased erosion.

- Placement of a groin within view of a historic structure may alter the visual aesthetics of such sites.

- Sites located in the area protected by the structure may be preserved.

(3) Submerged Cultural Resources

- Site preparation and construction may disturb submerged cultural resources.

- Alteration of the current patterns may subject submerged cultural resources to erosion.

c. Biological Criteria.

(1) Wetlands

- Introduction of this measure into or near a wetland environment could possibly adversely affect the dynamics of the shoreline wetland. Wetlands immediately downdrift of the groin may be subject to increased scour.

(2) Fisheries

- Groin installation and/or repair could alter or disturb shallow inshore fish habitat used for spawning, feeding, and nursery areas. Alteration could be due to excavation, turbidity, or buildup of intercepted littoral drift material.

(3) Wildlife

- Introduction of man-made groin structures would alter shorebird, amphibian, reptile, and mammal habitat along the shoreline.

- There would be some temporary disturbance to existing shoreline wildlife during initial construction and during periodic maintenance in the project vicinity.

- More beach zone would probably be created by installed groins and their resultant interception of wave-generated material.

- Some calmer shallow shoreline habitat would be temporarily created in the immediate vicinity near groins.

(4) Threatened or Endangered Species

- Whether or not possible loss of significant habitat and disturbance to any rare and endangered fauna and flora would occur, would be investigated through coordination with State and Federal fish and wildlife agencies during subsequent planning stages.

(5) Benthos

- Increased erosion protection to the shoreline provided by groins would contribute toward some temporary benthic habitat stabilization in the project locale. However, there would also be some loss of existing benthic habitat by covering due to accumulation of wave-current materials intercepted by the structure.

- Temporary disturbance of benthic habitat would occur in the immediate project locale during construction and maintenance periods; some existing community composition would be changed.

- Some loss of existing benthic habitat could occur immediately downdrift of the groin in areas that may be subject to increased scour. Benthos organisms at the groin installation site would be destroyed by excavation or by covering with structural material.

- Composition of the existing benthic community would be changed.

(6) Littoral Zone

- Temporary reduction in sunlight penetration would occur during construction and maintenance periods due to turbidity from resuspended bottom sediments and detritus along the shoreline.

- Groins would reduce littoral transport of material by wave-generated currents, and beach buildup would occur in the project area's existing littoral zone.

- Groins would be ineffective in trapping sediments in areas of low littoral drift.

(7) Vegetation

- Interception of materials from reduced wave-generated currents due to groins would continue to cover some shoreline aquatic vegetation. However, some more stable aquatic substrate for vegetation growth or attachment may also be created.

(8) Air Quality

- There would be some temporary, unavoidable, adverse impact on air quality due to increase in dust and odor, during use of any construction equipment at the time of project implementation and during maintenance periods.

(9) Water Quality

- Temporary increase in water turbidity during construction and maintenance periods would unavoidably occur.

(10) Nekton and Plankton

- There may be some possible interference with shoreline fish migration routes due to projection of groins outward from shore and due to potential of such a structure to intercept wave-generated current material that could form a beach in the nearshore littoral zone. Immediately downdrift of the groin, the area could be subject to increased scour which may or may not interfere with fish migration. Such interference could cause changes in migration course and potentially expose inshore migrating fish to potential new hazards (e.g., predators, sewer outfalls, intakes, etc.).

- No significant impact on plankton is anticipated, although construction and maintenance activity could displace or destroy some minute inshore floating plant-animal life in the water.

(11) Terrestrial Soils and Bottom Substrate

- Reduction in terrestrial soil loss would be expected due to the resulting increased beach protection provided by the structural measure.

- Some existing bank soil and bottom substrate would be disturbed or displaced during construction and maintenance periods.

- Soil on the immediate project site would be continuously subjected to accumulation of intercepted granular material alongshore. This would alter existing soil composition.

(12) Topography

- Some change in bottom and terrestrial relief would occur due to installation of the structure. Degree of relief change would also depend upon the amount of wave-generated current material intercepted by the groins.

(13) Federal/State Fish and Wildlife Areas

- Coordination with fish and wildlife agencies would be maintained to avoid conflict with existing or proposed management plans.

d. Other Environmental Criteria.

(1) Erosion

- Long-term reduction in loss of terrestrial shoreline soil is expected due to increase in erosion protection provided by the groins.

- Groins can be outflanked, thereby potentially shifting erosion problems to another area nearby. The area immediately downdrift of an installed groin may be subject to increased scour.

(2) Sedimentation

- There would be an increase in littoral drift material settling out around groins. Part of the sediment material that normally move alongshore by wave-generated currents would be intercepted along the shoreline.

(3) Water Levels and Flows

- Some diversion of alongshore littoral flows would be anticipated in the vicinity of installed groins and possibly in the area of lakeshore immediately downdrift.

- No significant impact on water levels is anticipated.

(4) Productivity

- Existing productivity on the project site would be disrupted or destroyed.

- Continuous settling out of alongshore littoral drift material trapped by groins would tend to provide unstable aquatic habitat that may cover existing biomass in the project locale. Buildup of beach material by groins would help retard soil erosion and protect shoreline bank soils, thereby providing for increased soil stability which could improve habitat for growth of terrestrial biomass plants and production of associated vertebrate and invertebrate organisms.

e. Economic Criteria.

(1) National Economic Development

- The increase in beach size could induce more recreationists to visit beaches and thereby increase national output.

- Value to unemployed or underemployed resources due to the construction of the project.

(2) Local Government Finance

Taxes - The groin's structure is likely to induce beach development. Recreational activities in surrounding areas could be increased as a result. The inducement to develop recreational sites could result in supportive facilities to accommodate recreationists and beach users. Then these supportive facilities such as restaurants and grocery stores could retrieve higher property tax revenues for the local Government.

- Taxes to the local Government could increase as local cost-sharing loads increase to maintain groin structures.

Property Values - If the groins protection is provided in residential areas, property values could be enhanced.

- Areas immediately downdrift of groins may feel increased erosion.

- The depreciation of the structures would increase due to an increase in erosion. Thus, there would be a decline in property values.

Public Facilities - Groins could result in increased benefits due to protection of sewage and water treatment and other plants along the shoreline or upland areas protected by groins.

- Public facilities downdrift of groins could be adversely impacted.

Public Services - Commercial recreational facilities would require increases in public sewage and water treatment services.

(3) Regional Economic Development

Real Income Distribution - Groins result in increasing participation in outdoor recreation due to expanded beach size.

- Income to suppliers of goods and services such as travel, equipment, lodging expenses, and other items will increase due to expenditures by recreationists. In certain areas, the tourist expenditures may well be the livelihood of local residents.

- Some of the income is used to buy goods and services produced locally while some is used to pay wages, salaries, profits, interest, and rents to members of the local community.

- Project implementation would result in income to unemployed and underemployed resources.

Employment/Labor Force - Recreationists demand local goods and services which results in expansion of employment opportunities in the local economy.

Business/Industrial Activity - Increased sales of retail business establishments due to recreationist activity and summer home ownership.

- Increase in sales of commercial establishments related to park activities.

Agricultural Activity - The construction of groins may reduce the quality of soil in the downdrift areas and reduce agricultural productivity.

- Displacement of farms could occur if commercial and residential land use increases.

7.3.2 BULKHEADS, SEAWALLS, & REVETMENTS

a. Social Criteria.

(1) Population Density

- Generally, this type of shoreline protection suggests long-term shoreline stability and a sense of increased security to shoreline property owners, thereby inducing initial and/or additional developments. If this occurred, it would contribute toward increased population density along the shoreline.

(2) Population Mobility

- If this measure was implemented, flood or erosion protection provided may stimulate increased development, which could promote or provide opportunity for additional movement of people onto lands along the coastal zone.

(3) Housing

- Construction of bulkheads, seawalls, or revetments may induce new or expanded residential development near protected shoreline banks.

(4) Displacement of People

- If needed, displacement of some people may be necessary in acquisition of shoreland area for structure construction.

(5) Transportation

- This measure may require construction of access roads to build and maintain structures.

- Shoreline protection provided by the structures could be an incentive for developing new or expanded transportation facilities along the shoreline.

(6) Desirable Community Growth

- Protection provided by this measure could stimulate further residential and commercial growth along the shoreline. If this occurred, expansion of community services and facilities may also follow.

(7) Aesthetic Values

- Construction of bulkheads, seawalls, or revetments would alter the existing shoreline setting. Some structures may be considered aesthetically unpleasing; they may obstruct the existing scenic view or access to scenic views.

(8) Institutional Dynamics

- Project implementation would probably require efforts to develop necessary interorganizational coordination and cooperation (development planning, easements, real estate, etc.).
- Project completion would probably require future planning, management, and facilitative techniques relative to future community growth.

(9) Health & Safety

- This measure would provide increased protection from flooding and erosion to shoreline residents.
- This measure may indirectly subject the increased population associated with new development to shoreline hazards (e.g., the protection structures provide may be a safety hazard).
- The protection structures may provide residents with a false sense of complete security from erosion hazards.
- Bulkheads, seawalls, or revetments may provide habitat for rodents (e.g., rats).

(10) Community Cohesion

- Provided protection could act as a community cohesive force.
- This measure may induce conflict relative to protection needs, costs, and future development.
- Possible displacement of people which may be associated with this measure, could impact upon community cohesion.

- The construction process, resulting structures, and altered shoreline characteristics may inpact upon normal community function, thus affecting community cohesion.

(11) Noise

- If this measure is implemented, temporary construction noise would unavoidably occur during initial installation of structures and during maintenance periods.
- Installation of shoreline protection structures could contribute to increased noise to nearby residents as waves pound against such structures.
- There could be temporary noise associated with any new developments that occur in areas provided with shoreline protection.

(12) Leisure, Cultural, and Recreational Opportunities

- Shoreline protection structures may either hinder or provide for improved access to the shoreline and water-oriented recreation opportunities.
- This measure may encourage continued shoreline development and it may limit or reduce the rate of sediment nourishment to beaches.
- Such structures may provide possible fishing and/or shoreline access.

b. Cultural Resources.

(1) Archaeological Sites

- Archaeological sites may be disturbed by ground preparation and construction during implementation of structural features associated with this measure.
- Sites located in areas adjacent to the protection structures may be subject to increased erosion.
- Archaeological sites within the area protected by the structure may be preserved.

(2) Historical and Architecturally Significant Structures

- Placement of protection structures within view of a historic structure may alter existing visual aesthetics.
- Ground preparation and construction may alter portions of buildings or their associated grounds which in turn could impact the historic integrity of cultural resource sites.

- Indirectly, shoreline protection structures may help preserve nearby historical and architectural sites.

(3) Submerged Cultural Resources

- Submerged cultural resources may be disturbed.

- Submerged cultural resources may be subjected to erosion (through change in current patterns) by implementation of this measure.

c. Biological Criteria.

(1) Wetlands

- Introduction of these structural measures near adjacent wetlands could have an adverse impact on such habitats, since bulkheads, seawalls, and revetments provide no protection to adjacent areas along the shoreline which could continue to erode. Flanks of protected property may become exposed, and eroded bank material could continue to cover over fauna and flora associated with adjacent wetlands.

(2) Fisheries

- Such structures may eliminate or greatly reduce in quantity or quality valuable habitat such as shallow inshore areas and the inshore water interface. There could be loss of shallow inshore fishery areas used for spawning, feeding, and nursery areas at the immediate project site and/or along its flanks.

- Vertical walls associated with bulkheads and revetments may also create reflection waves that disturb bottom sediments and habitat at the base of such structures. Additional habitat may be destroyed during the construction phase if backfill for structures is obtained by dredging.

(3) Wildlife

- Installation of such shoreline measures could result in some loss of, or disturbance to, terrestrial or semi-terrestrial shoreline wildlife habitat.

- Most wildlife would probably be displaced from shoreline habitats during construction and maintenance periods.

(4) Threatened or Endangered Species

- Whether or not possible loss of significant habitat and/or disturbance to any rare or endangered fauna and flora would

occur, would be investigated through coordination with Federal and State fish and wildlife agencies during subsequent planning stages, if the study is further authorized and funded by Congress.

(5) Benthos

- Some alteration or destruction of existing inshore benthic habitat would occur during construction and maintenance periods. Some benthic organisms would be covered by structural material or excavated out of the site at which such structures are installed.

- Stone revetments may provide increased submerged surface area for use by benthic organisms.

(6) Littoral Zone

- Unavoidably, fauna-plant communities would be disrupted to some degree in the shallow water zone along the shoreline during construction and maintenance periods. Turbidity would contribute to temporary reduction in sunlight penetration; substrate habitats would be removed or displaced along with associated invertebrates and/or aquatic plants. If backfill for protective structures is obtained by dredging, it is assumed that about 3 acres of submerged sediments are required for each acre of filled land (USFWS letter dated 7 February 1980). This could eliminate or reduce the quantity or quality of inshore aquatic habitat.

(7) Vegetation

- Installation of these structures may remove, cover, or alter some existing aquatic and/or terrestrial vegetation and habitat along the shoreline.

(8) Air Quality

- Some temporary, unavoidable, adverse impact on air quality is anticipated due to an increase in dust and odor during use of any construction equipment at the time of project implementation and during maintenance periods.

(9) Water Quality

- Disturbance of sediments, riparian, and aquatic flora along with associated invertebrates would contribute temporarily to an increase in water turbidity during project construction and maintenance periods.

- Spillage of some fuel, oil, and grease during construction and maintenance activity by heavy equipment may occur.

(10) Nekton and Plankton

- Some inshore forage and predator fish may be displaced from shallow water habitats at the immediate project site and temporarily in the turbidity zone downdrift.

- No significant impact on plankton is anticipated, although construction and maintenance activity could displace or destroy some minute inshore floating plant-animal life in the water.

(11) *Terrestrial Soils and Bottom Substrate*

- Terrestrial shoreline soils behind bulkheads, seawalls, and revetments would be provided long-term increased protection. Potentially, soils along unprotected flanks may experience adverse impact, if deflected waves off such structures shift the erosion problem.

(12) *Topography*

- Installation of man-made shore protection structures would change existing relief features both horizontally and vertically.

(13) Federal/State Fish and Wildlife Areas

- Coordination with fish and wildlife agencies would be maintained to avoid conflict with existing or proposed management plans.

d. Other Environmental Criteria.

(1) Erosion

- Installation of these structures would reduce erosion along shoreline areas directly protected. However, they may also contribute to new or increased erosion along flank areas. Natural surface or subsurface drainage may be rerouted which could contribute toward erosion along the ends of such structures.

- Erosion could undermine protective structures, thereby requiring a need for periodic maintenance.

(2) Sedimentation

- Existing shoreline sediment patterns would probably be altered to some degree by installation of protective structures.

- Some bank sources for sediment material supply necessary to maintain natural beaches and shoals downdrift may be reduced or eliminated, if bank stabilization structures are installed.

Vertical or slanted walls of protective structures may also create reflection waves that further disturb inshore sediments.

(3) Water Levels and Flows

- No significant impact on lake water levels is anticipated if such structures are installed.

- Depending on where bulkheads, seawalls, and revetments are installed, there could be some adverse or beneficial effect on littoral zone flows. Some diversion of alongshore flows would be anticipated in the vicinity of installed structures and possibly in the lakeshore immediately downdrift.

(4) Productivity

- Existing productivity on the project site would be disrupted or destroyed.

- Protected terrestrial habitats would be provided more soil stability; thereby potentially contributing toward improved habitat for growth of plants and production of associated vertebrate and invertebrate organisms.

e. Economic Criteria.

(1) National Economic Development

The benefits to the national output accrue due to the reduction in flood damages. Bulkheads, seawalls, and revetments provide flood control and reduce physical damages to buildings, reduce income losses sustained due to flooding, and reduce flood emergency costs such as disaster relief.

(2) Local Government Finance

Taxes - Flood and erosion protection provided by these devices will enhance recreational and commercial property values. This would enlarge the tax base and secure higher tax revenues.

- Induced development in shoreline and upland areas would result in a new future source of tax revenues.

- Residential development along the shoreline also includes seasonal dwellings. Summer residents pay taxes out of income earned outside the area.

Real Property Values - Enhanced property values due to flood and erosion protection.

- The depreciation of commercial and residential structures would decrease due to reduced erosion rates and increased shoreline stability.

Public Facilities - There will be an increased need for the electricity, gas, power, water, and sewage plants which service the developing communities.

- Summer development has lower public facility requirements since the owners are not year-round residents. The extent or need for public facilities will depend on the type of residential development which occurs in protected shoreline and upland areas.

Public Services - Induced commercial and residential development will result in larger demands in public services. The extent of the demand will also be related to the nature of the residential development whether it be seasonal or year-round. Summer residents require fewer services, in that, children will go to school elsewhere, roads to their homes need not be cleared of snow in the winter, rural settlement patterns would require septic tanks reducing need for public sewer lines for induced development.

(3) Regional Economic Development

Real Income Distribution - Expansion of commercial activities will result in greater income supplied to the local area. Income generated by the new activities induced by flood and erosion control protection will also yield greater returns in wages, salaries, profits, and rents to members of the local community.

- Project construction would result in income to underemployed or unemployed resources. These benefits are classified as area redevelopment benefits.

Employment/Labor Force - Induced development in commercial/retail establishments would result in added sources of employment for the protected shoreline and upland areas.

Business/Industrial Activity - Retail business establishments will garner increased incomes due to flood damage reduction resulting from installation of protective devices. Induced development of commercial activities will also occur due to flood damage reduction.

Agricultural Activity - Flood and erosion protection will improve the quality of the soil. Agricultural productivity will increase as a result of the improvements due to protective devices.

7.3.3 BEACH NOURISHMENT

a. Social Criteria.

(1) Population Density

- Implementation of this measure would provide increased protection to shoreline properties by dissipating wave energy before it reached erodible backshore land.

- Provided shoreline protection could stimulate some new or expanded residential or commercial development. If this occurred, population density would probably increase along such coastal areas.

(2) Population Mobility

- This structural measure requires continuous maintenance and also may promote beach-type developments, which could, to some extent, provide opportunity for increase in population into and out of the area along the beach-shoreline interface.

(3) Housing

- If development is induced by this measure, it could provide opportunity to build new or expanded residential or commercial housing along the shoreline.

(4) Displacement of People

- Generally, no additional shoreland area is required for this method of protection. However, since beach nourishment material may be brought into a project site from onshore lands (as well as from offshore sites), there is some possibility (although perhaps remote) that some displacement of people could occur.

(5) Transportation

- Induced development stimulated by this measure could, in turn, promote new or additional forms of transportation developments; this may expand use of beach-type vehicles on increased beach area provided.

(6) Desirable Community Growth

- The beach nourishment process would protect and/or promote beach-type activities and developments; this may require expansion of additional facilities and services to accommodate growth.

- Depending on community goals and values, the induced developments could be beneficial or adverse.

- This measure may require management and policies regulating developments.

- This measure could disrupt function of existing adjacent facilities and/or existing protective structures (intakes, outflows, erosion control structures).

- Provision for borrow area and source material, transportation, and dispersion process would be necessary if this measure was implemented.

(7) Aesthetic Values

- This measure would generally maintain the existing natural setting and could be considered aesthetically pleasing (provided that clean material is used).

- This measure would probably increase shoreline turbidity and sedimentation which would temporarily adversely affect aesthetic appearance of inshore water.

(8) Institutional Dynamics

- Project development would require interorganizational coordination and cooperation (long-term, continuous); it may require alternative management, planning and facilitative measures relative to future developments.

- This measure would provide increased protection to shoreline uplands by periodically replenishing eroded beach areas with new material. This may also help alleviate easement and possible property ownership problems along some coastal lands.

(9) Health & Safety

- Artificial beach nourishment would provide some increased degree of safety to inhabitants of existing residences against structural failure due to erosion, by dissipating wave energy beyond the immediate shoreline.

- Induced developments stimulated by this measure may subject increased population to shoreline hazards.

(10) Community Cohesion

- Provided structural shoreline protection could act as a positive community cohesive force. However, it may induce conflict relative to protection needs, cost and future development interests, as well as possible conflict over agreement on borrow site, transport, and fill distribution process.

(11) Noise

- Relative to this measure, noise from construction and maintenance process activities (borrow site, transport, fill) would be unavoidable.

- If new or expanded development activity occurs in the vicinity of areas maintained by beach nourishment, temporary construction noise associated with such activity would occur.

(12) Leisure, Cultural, and Recreational Opportunities

- This measure may be inducive to beach-type development and activities. It may provide opportunities for park or beach expansion as well as improved shoreline access.

b. Cultural Resources.

(1) Archaeological Sites

- Sites in beach material supply areas may be disturbed by removal of borrow if this measure is implemented.

- Since this measure would help dissipate wave energy forward of the beach-terrestrial shoreline interface, archaeological sites would be provided increased protection against destruction or alteration by erosion.

(2) Historical and Architecturally Significant Structures

- Sites in supply areas may be disturbed by removal of borrow if this measure is implemented.

- Sites in the area to be protected may be preserved by protection provided against bank erosion.

(3) Submerged Cultural Resources

- Sites in the area of the beach may be buried.

- Alteration of the current patterns that may result from beach formation may subject submerged cultural resources to erosion.

c. Biological Criteria

(1) Wetlands

- There is a possibility that beach nourishment on the lakeward side of barrier-beach wetlands may contribute toward hindering free interchange of water between the lake and such wetlands.

- Beach nourishment could potentially hinder nutrient exchange rates that may occur between the lake and wetlands, as well as hinder outflow of detritus into the lake from wetlands.

(2) Fisheries

- Beach nourishment could potentially hinder egress-regress of lake fish species that depend upon movement to wetlands for spawning.
- Displacement of fish species from the project site would be anticipated; some young fish along the immediate aquatic shoreline may be destroyed during deposition of material.

(3) Wildlife

- Temporary disturbance to shoreline-beach wildlife during beach nourishment activities would be unavoidable.
- Existing shallow shoreline habitats utilized by wildlife (e.g., wading and shorebirds, amphibians, reptiles, mammals) would be covered.

(4) Threatened or Endangered Species

- Whether or not possible loss of significant habitat and disturbance to any rare or endangered fauna and flora would occur, would be investigated through coordination with State and Federal fish and wildlife agencies during subsequent planning stages.

(5) Benthos

- Existing invertebrates and invertebrate habitat would be covered by nourishment material and some suspended silts would probably settle out in the littoral zone downdrift.
- Material settled out downdrift would probably disturb, alter or create some new benthic habitat.

(6) Littoral Zone

- Temporary decrease in light penetration would occur due to construction and maintenance activity.
- There would be an increase in availability of littoral material for future current transport.
- Some aquatic and/or terrestrial flora may be destroyed.
- The littoral zone would be destroyed or would become shallower where beach nourishment is done; some change in fauna-flora communities would probably occur.

(7) Vegetation

- Beach nourishment activities would cover some existing aquatic and terrestrial shoreline plants.
- Nourishment material needed to periodically maintain beaches according to design, would contribute toward causing disturbance and instability to plant habitat, that could hinder long-term establishment and growth of vegetation in the area of impact.

(8) Air Quality

- There would be some temporary, unavoidable adverse impact on air quality due to increase in dust and odor, during use of any construction equipment at the time of project implementation and during maintenance periods.

(9) Water Quality

- Temporary increase in water turbidity would occur during construction and maintenance periods.
- Spillage of some fuel, oil, and grease during construction and maintenance activity by heavy equipment may occur.

(10) Nekton and Plankton

- There may be some possible interference with shoreline fish migration routes. Such interference could cause changes in migration course and potentially expose migrating fish alongshore to new hazards (i.e., predators, sewer outfalls, intakes, etc.).
- No significant impact is anticipated with regard to plankton, although construction and maintenance activity could displace or destroy some minute plant-animal life in the water.

(11) Terrestrial Soils and Bottom Substrate

- Depending upon type of material used for beach nourishment deposition, the existing soil composition on the borrow site and deposition site could be significantly changed both during construction and maintenance periods.

(12) Topography

- Change in bottom and terrestrial relief would occur, but degree of change at borrow and deposition sites would depend upon the amount of nourishment material extracted and deposited.

(13) Federal/State Fish and Wildlife Areas

- Coordination with fish and wildlife agencies would be maintained to avoid conflict with any existing or proposed management plans.

d. Other Environmental Criteria.

(1) Erosion

- As long as artificial beach nourishment continues, degree of erosion along the shoreline would be reduced (long-term), since wave action and associated energy would be significantly dissipated before reaching the erodible backshore.

(2) Sedimentation

- This measure would contribute toward an increase in available material for natural wave and current transport alongshore.

(3) Water Levels & Flows

- Some diversion of shoreline littoral flows would be anticipated where artificial beach nourishment occurs.
- No significant noticeable impact on water levels is anticipated by implementation of this measure.

(4) Productivity

- Existing game, nongame, plant, and invertebrate productivity at borrow and fill project sites would be disrupted or destroyed.
- Unstable habitat provided by annual or periodic nourishment activities would continually disrupt existing shoreline associated fauna and flora, which could reduce amount of biomass or change biomass composition in the project locale.

e. Economic Criteria.

(1) National Economic Development

Recreational activities could be encouraged by the use of nourishment measures. The increased number of recreationists will provide added value to national output on the basis of willingness to pay.

The value to unemployed and underemployed resources during the construction period is a benefit to national output.

(2) Local Government Finance

Taxes - The nourishment is likely to encourage recreational activities. Recreational activity availability could enhance property values. The increase in property values would garner larger tax revenues for the local Government. Taxes to local Government would increase as local cost-sharing loads increase to maintain nourishment.

Real Property Values - The enhancement of recreational activities could result in higher property values due to availability of the recreational activities.

Public Facilities - Public facilities could be less effective, due to sand nourishment. The sand beach buildup could reduce effectiveness of intakes and outflows by expanding beach size and lowering nearshore water depths.

Public Services - The services would be increased if recreational activities encouraged the expansion of recreational commercial establishments.

(3) Regional Economic Development

Real Income Distribution - Beach nourishment provides aesthetically pleasing beaches and encourages recreational participation.

- Income to suppliers of goods and services such as travel, equipment, lodging expenses, and other items due to expenditures by recreationists. Some of the income is used to buy goods and products produced locally; some is used to pay wages, salaries, profits, interest, and rents to members of the local community.
- Project implementation would result in income to unemployed and underemployed resources.

Employment/Labor Force - Recreationists demand local goods and services which results in expansion of employment opportunities in the local economy.

Business/Industrial Activity - Increased sales of retail business establishments due to recreationist and/or summer home ownership. Increased sales of commercial establishments related to park activities.

Agricultural Activity - Displacement of farms could occur if there is excessive demand for commercial land use.

7.3.4 LEVEES AND FLOODWALLS

a. Social Criteria.

(1) Population Density

- Would provide an increased degree of existing protection from flooding and erosion, generally to developed community areas or valuable agricultural areas along the shoreline.

- These structures may probably induce further development in the coastal zone.

- With improved protection and increased development, population density would probably increase.

- A construction work force would be needed during initial project installation and during maintenance periods; therefore, a temporary concentration of construction workers to accomplish these tasks would be available in the project zone.

(2) Population Mobility

- Project installation could be an inducement to more future development, which generally could promote and/or provide opportunity for population mobility into and out of the coastal zone.

(3) Housing

- Induced development as an impact provided by project installation could provide opportunity for residential development.

- There may be a possible need for housing workers nearer to the project site during construction and maintenance periods.

(4) Displacement of People

- Displacement of people may result in acquisition of land required for the construction.

(5) Transportation

- Provided protection that results in induced development, could in turn promote new or expanded forms of transportation development.

- These flood and erosion control structures may conflict with existing or proposed future shoreline transportation routes (including foot or vehicular access routes).

- Heavy equipment and vehicular maintenance access rights-of-way are generally required during and after project completion.

(6) Desirable Community Growth

- Such structures would probably protect and/or induce lowland shoreline development.

- Induced development would probably stimulate expansion of additional community services and facilities.

- Depending on community goals and values, levee and/or floodwall development may be considered by residents to be beneficial or adverse.

- Installation of structures may require that the community consider management and policies regulating future development in the area.

- The structures could provide increased protection to community water resource facilities.

- These structures could shift a flooding or erosion problem to adjacent or nearby lands, facilities, or structures.

(7) Aesthetic Values

- Such structures may be considered too unsightly or too man-made in appearance on the existing shoreline landscape; they would alter the natural setting.

- These structures could possibly obstruct the existing view or access to the view of the lake.

(8) Institutional Dynamics

- Project development and maintenance may require extensive interorganizational coordination and cooperation.

- Induced developments stimulated by protection provided may strengthen views and interests of various community organizations.

- Project implementation may require alternative management, planning, and facilitative meaures relative to future development.

- Prior to installation of structures, purchase of properties or property easements may be needed.

(9) Health & Safety

- The structures would provide some increased degree of safety to inhabitants of existing residences against structural failure due to flooding and erosion.

- Installation of such structures would probably increase a sense of security in the community residents.

- Induced development due to protection provided may subject increased population to shoreline hazards.

- The structures may be hazardous to walk on.

- Poor maintenance and mowing management of earth levees may provide habitat for rodents, reptiles, etc.

- Potential inland drainage problems could occur unless the structures are properly designed and maintained. Poor drainage behind structures could cause pooling of stagnant water and be a possible collection area for accumulation of pollutants and pathogenic organisms.

- Disrupted terrain during construction could be a temporary hazard to residents.

(10) Community Cohesion

- Provided protection could act as a community cohesive force.

- Installation of berms and levees may induce conflict relative to protection needs, cost, and future development interests.

- The construction process, resulting structure, and altered shoreline characteristics may impact upon normal community function, thus effecting community cohesion.

- Protection to one area may shift or create flooding problems to other residents and facilities in the community.

(11) Noise

- There would be temporary noise during construction and maintenance periods.

- There would be noise created during and after new development which could potentially occur in land areas protected by levees or floodwalls.

(12) Leisure, Cultural, and Recreational Opportunities

- These structures generally provide protection to lowland developed areas.

- Levees and/or floodwalls may alter or restrict access to use of the coastal zone in some cases; they could contribute toward restriction of some shoreline activities. However, in some instances, these structures may, where appropriate, provide access points for use in recreational fishing.

b. Cultural Resources.

(1) Archaeological Sites

- Sites located in the zone of construction and maintenance right-of-way may be disturbed by implementation of levees or floodwalls.

(2) Historical and Architecturally Significant Structures

- Sites located in the zone of construction and maintenance right-of-way may be disturbed.

- Placement of levees or floodwalls within view of a historic structure may alter visual esthetics of such cultural resources.

(3) Submerged Cultural Resources

- This measure, due to its nature, will not affect submerged cultural resources.

c. Biological Criteria.

(1) Wetlands

- Wetlands along the immediate design path of levees or berms could be destroyed or altered by construction excavation and/or covering with fill.

- Installation of levees or floodwalls near a wetland could alter soil drainage or surface water depths that may in turn destroy or disrupt existing aquatic fauna-flora communities dependent on short-term, seasonal, or long-term water level fluctuations.

(2) Fisheries

- No significant fishery impacts are anticipated, unless levees or floodwalls obstruct or prevent fish movement into an area that is normally utilized for spawning, feeding, or rearing of young.

(3) Wildlife

- Existing food, cover, and nesting habitat would be destroyed along the design path of levee and floodwall fill areas. Unavoidably, some additional habitat along these structures would also be destroyed or altered by heavy equipment during construction and maintenance periods.

- Installation of levees or floodwalls would reduce frequency of flooding on terrestrial wildlife habitats that are subject to water level fluctuations.

- Earthern levees would provide new terrestrial habitat. New food, cover, and nesting habitat would be introduced when disturbed soils are seeded and established with grass or grass-legume mixtures. However, since floodwalls would usually be constructed of concrete, there would be long-term elimination of natural wildlife habitat along the immediate floodwall design path.

- Habitats and wildlife would be disrupted, displaced, or destroyed in borrow areas from which earth was removed to construct levees.

(4) Threatened or Endangered Species

- Whether or not possible loss of significant habitat and disturbance to any rare or endangered fauna and flora would occur, would be investigated through coordination with State and Federal fish and wildlife agencies during subsequent planning stages.

(5) Benthos

- Since levee earthen embankments would be constructed on terrestrial lands, no direct significant impact on benthos is anticipated. Indirectly, temporary soil erosion that could occur on disturbed land during construction may wash into water alongshore during rainy periods and cover some benthos. Floodwall construction at the water/terrestrial shoreline interface may destroy or disrupt some existing invertebrates.

(6) Littoral Zone

- If levees or floodwalls are installed in upland areas, no significant impact on the littoral zone or land/water interface is anticipated.

- If levees or floodwalls are installed in shallow littoral or water/land interface areas, aquatic fauna-flora habitats may be destroyed or altered.

(7) Vegetation

- Placement of material to construct levees or floodwalls could cover existing terrestrial and/or wetland vegetation. Trees and shrubs within the design pathway of such structures would be removed.

- New vegetation would need to be planted on disturbed terrestrial soils.

- Some vegetation in the zone of construction equipment activity outside the immediate location of levee or floodwall structures

may be destroyed or plant communities may be altered in species density and/or composition.

(8) Air Quality

- There would be some temporary, unavoidable adverse impact on air quality due to increase in dust and odor, during use of any construction equipment at the time of project implementation and during maintenance periods.

(9) Water Quality

- Temporary erosion that could occur on disturbed unvegetated land during construction may wash soil particles into water alongshore during rainy periods and contribute to short-term water turbidity.

(10) Nekton & Plankton

- No significant impact on plankton is anticipated by construction of levees. Construction and maintenance activity of floodwalls along the shallow aquatic/terrestrial shoreline interface could destroy or displace some minute plant-animal life in the water.

(11) Terrestrial Soils and Bottom Substrate

- There could be some covering or alteration possible of prime and unique farmland on areas of levee construction and maintenance rights-of-way near the shoreline.

- Soils in the zone of construction activity would unavoidably receive increased compaction by heavy equipment. Compaction may contribute to permeability and drainage problems (e.g., shallow pooling) unless proper drainage is provided.

- No significant impact on alongshore bottom substrate is anticipated by installation of levees. Floodwall construction along the aquatic/terrestrial shoreline interface could disrupt or displace bottom substrate.

(12) Topography

- The existing land surface relief would be altered and land elevation in the immediate zone of levee installation would be raised.

(13) Federal/State Fish and Wildlife Areas

- Coordination with fish and wildlife agencies would be maintained to avoid conflict with any existing or proposed management plans.

d. <u>Other Environmental Criteria</u>.

(1) <u>Erosion</u>

- Increased protection provided to developed and undeveloped areas alongshore would decrease flooding frequency and thereby decrease rate of soil erosion from surface runoff.

- Wind or rainfall runoff soil erosion may temporarily occur on exposed disturbed soils in the zone of construction, until new seeding on such areas becomes established to provide cover.

(2) <u>Sedimentation</u>

- No significant impact with regard to sedimentation from installation of these structures is anticipated, however, some wind-blown shifting of sediment or some surface runoff of soil due to erosion by rainfall in the zone of project activity may temporarily occur.

(3) <u>Water Levels and Flows</u>

- No significant noticeable impact on lake water levels would probably occur.

- Installation of levees or floodwalls may shift direction of existing surface runoff flows.

(4) <u>Productivity</u>

- Some adverse impact on actively nesting terrestrial wildlife could occur, if construction takes place during the nesting season.

- Some existing productive soil acreage (e.g., prime and unique farmland) could be adversely impacted, either directly or indirectly by installation of levees or floodwalls. Directly, fill material needed to build levee structures could cover productive soils and eliminate acreage from active cropping. Indirectly, levees may alter surface drainage patterns that could cause or shift surface pooling to other nearby croplands, or restrict farming equipment from access to crop fields until lands drain.

e. <u>Economic Criteria</u>.

(1) <u>National Economic Development</u>

- The benefits to the national output accrue due to the reduction in flood damages. Levees and floodwalls provide flood control and reduce physical damages to buildings, reduce income losses

sustained due to flooding, and reduce flood emergency costs such as disaster relief.

- Benefits also accrue to agricultural production. The costs of damages to crops due to erosion and flooding is reduced. Levees and floodwalls would reduce the need for high maintenance and replacement costs for irrigation, drainage, or flood protection systems. The provision of protection would allow the planting of a larger variety of crops as well as those that are tolerant of flood, erosion, or wet soil conditions.

- Income to underemployed or unemployed resources during the construction period.

(2) Local Government Finance

Taxes - The response of the tax base to the installation of levees and floodwalls will depend on the induced development and the extent of development. An increase in tax collection will occur as the shoreline is claimed for more intensive land use purposes.

Property Values - The growth in metropolitan property values exceeds the growth in rural land values. Levees and floodwalls will protect property against erosion and flooding and result in higher property values.

Public Facilities - The levees and floodwalls could provide protection to water resource facilities in the protected communities. Electricity, gas, power, water and sewage, and transportation facilities are inclusive. The protection of roads and public transportation facilities along the shoreline would encourage further development since they are important features for an area's development.

Public Services - Since levees and floodwalls are generally constructed to protect existing communities, further development is likely to occur. In order to meet the demands of an urbanized area, further public facilities will need to be provided. Much of the shoreline residential development will occur in rural areas where municipal facilities will be economically difficult to construct. About 30 percent of the housing stock relies on on-site sewage disposal systems in the study area.

(3) Regional Economic Development

Real Income Distribution - The expansion of commercial activities in protected communities will expand the income sources for the local community. The new and expanded businesses provide wages to the local populace. Unfortunately, the Lake Ontario Shoreline area is not concentrated in industrial activity which is the heavy taxpayer in relation to the direct Government costs it creates. Income generation is reliant on commercial and recreational activities. Project construction period will provide benefits to unemployed or underemployed benefits. In order to qualify, the area must be eligible according to criteria set forth in the Public Works and Economic Development Act of 1965.

Employment/Labor Force - Expansion of local commercial activities would result in reducing local unemployment or attract new people to the community. Skilled labor is more likely to be drawn from outside the labor pool. The shoreline counties employment is concentrated in the service industries and retail trade. The increase in local employment will result in subsequent increases in local personal per capita incomes.

Business/Industrial Activity - Levee and berm protection will encourage business activities to expand due to flood and erosion protection. The reduction in physical damages to structures and reduced income loss will lower risks of operation in floodprone areas. Future losses will also be reduced as inventories receive additional protection.

7.3.5 OFFSHORE BREAKWATERS

a. Social Criteria.

(1) Population Density

- This structure would provide some degree of erosion protection to the shoreline. Due to increased shoreline protection provided, offshore breakwaters may indirectly induce creation of new or expanded inlet or harbor development.
- With shoreline protection and development, population density would probably increase to some degree along the coastline; this increase may be year-round or seasonal.

(2) Population Mobility

- This type of structure requires construction and induces development which generally could promote and/or provide opportunity for population movement into and out of the coastal zone.

(3) Housing

- Induced development could provide opportunity for new or expanded development.

(4) Displacement of People

- Since no shoreland area is required for this type of offshore protection structure, no significant displacement of people is foreseen.

(5) Transportation

- Induced shoreline developments could, in turn, promote need for expansion of transportation facilities.
- Characteristically, offshore breakwaters provide inshore protection for boating.

(6) Desirable Community Growth

- The structure could induce new or expanded beach, inlet, or harbor development;

- This development could require expansion of additional community services and facilities;

- Depending on community goals and values, the induced developments could be beneficial or adverse;

- Improved erosion protection may indirectly require a need for consideration of management and policies regulating future shoreline development;

- Implementation of offshore breakwaters could disrupt function of existing man-made adjacent facilitative and/or protective structures (sedimentation to intakes, dissipation from outflows).

(7) Aesthetic Values

- The breakwater structure may be considered unsightly;

- It would alter the natural setting;

- It may obstruct the existing view.

(8) Institutional Dynamics

- Project development would require some interorganizational coordination and cooperation.

- Potential for induced shoreline developments may strengthen views and interests of various public and private organizations (e.g., agreement, conflict, etc.).

- May require alternative management, planning, and facilitative measures relative to future developments.

- Offshore breakwaters could alter property ownership problems.

(9) Health & Safety

- Such a structure would provide increased protection against erosion problems due to wave action.

- Induced coastal zone developments may subject the associated increased population to shoreline hazards, since it is probable that they would utilize the lakeshore more often.

- Structure may be hazardous to walk on and to recreation boaters.

- The structure may increase a false sense of total safety from the effects of shoreline erosion to some property owners.

- By decreasing wave force or action, the breakwater would probably make the shore side calmer and safer for recreationists - especially during sudden storm periods.

- Breakwaters could indirectly contribute to water stagnation by creating calmer water between the structure and the shore; also, such calmer water zones could help concentrate pathogenic organisms and pollution sources nearby.

(10) Community Cohesion

- Provided shoreline erosion protection could act as a community cohesive force, or it may induce conflict relative to protection needs, cost, and future development interests.

- The construction process, resulting structure, and altered shoreline characteristics may impact upon normal community function.

- Protection to one shoreline area may create problems in another coastal location.

(11) Noise

- There would be temporary noise during construction and maintenance periods.

- Wave action noise at the installed breakwater would be anticipated, which may or may not be a problem to residents - depending on how far from shore breakwaters are installed.

- Resulting development noise. There would be noise created during and after new or expanded development which could potentially occur in the protected sheltered zone behind breakwaters.

(12) Leisure, Cultural, and Recreational Opportunities

- The structure would probably provide some degree of wind protection and reduced wave action to water-related activities and facilities behind it, thereby potentially providing more opportunity to utilize the coastal zone.

- Breakwaters would provide possible offshore fishing access.

- Breakwaters may induce new or expanded possible park, beach, and marina development.

b. Cultural Resources.

(1) Archaeological Sites

- Downdrift erosion may disturb buried sites along the shoreline.

- Archeological sites protected by the breakwater may be preserved.

(2) Historical and Architecturally Significant Structures

- Downdrift erosion may disturb the foundations of historic structures.

- Placement of this structure within view of a historic structure may alter its visual aesthetics.

- Structures protected by the breakwater may be preserved.

(3) Submerged Cultural Resources

- Breakwater site preparation and construction may disturb submerged cultural resources.

- Alteration of current patterns may erode or bury submerged cultural resources.

c. Biological Criteria.

(1) Wetlands

- Since breakwaters are designed to serve as wave attenuators and to trap drift material, placement of such structures near or in wetlands could destroy or disrupt existing conditions of such areas.

- Breakwaters may alter or interrupt existing water circulation patterns which can result in the downdrift erosion of shore areas.

(2) Fisheries

- Trapping of drift material by breakwaters may cover offshore or onshore fish spawning, nursery or feeding habitats.

- Breakwaters would introduce new, stable, rough surface habitat for fish. The submerged portion of breakwaters could increase the amount of rough surface area for use as feeding, spawning, or shelter habitat for some fish species.

- Temporary displacement of fish to move out of the construction disturbance zone would occur; also temporary displacement of fish would be anticipated during maintenance periods. Once the breakwater was installed and turbidity subsided, it is probable that some fish species would recolonize new habitat provided by the submerged stone.

(3) Wildlife

- Breakwater stone above the water line would provide new habitat for some species of aquatic birds (e.g., seagulls).

- The area between an offshore breakwater and the shoreline may provide a potential sheltered, calmer water zone for waterfowl and shorebirds.

- Since breakwaters would alter existing littoral transport, such structures could cause sand starvation and erosion at a downdrift area which could potentially affect some existing shoreline wildlife habitats.

- There would be temporary disturbance to, and displacement of, aquatic birds during construction and maintenance periods in the general zone of heavy equipment activity.

(4) Threatened or Endangered Species

- Whether or not possible, loss of significant habitat and disturbance to any rare or endangered fauna and flora would occur, would be investigated through coordination with State and Federal fish and wildlife agencies during subsequent planning stages.

(5) Benthos

- Benthic organisms in the immediate breakwater site would be covered by stone; sediment and silt disturbance, suspension, and redeposition would cover over some invertebrate habitat around the immediate impact site and downdrift during construction and maintenance periods. Some benthic communities would also be covered by the resulting buildup of littoral material.

- Introduction of stone would provide a stable long-term aquatic habitat. This new habitat would alter existing biological composition of the benthic community in the immediate construction locale.

- There could be some change in existing benthic habitat downdrift due to altered littoral transport, sand starvation, and erosion in downdrift areas, which could potentially occur if breakwaters are installed.

(6) Littoral Zone

- There would be some change in existing water current patterns in the vicinity of the installed breakwater; this could alter existing littoral transport of material (e.g., plankton).

- Temporary turbidity during construction and maintenance periods would correspondingly cause temporary reduction in sunlight penetration.

- Possible alteration or destruction to existing shoals at the project site and/or in nearby areas downdrift could occur during and after construction. Some decrease in water depth at or downdrift may occur as littoral drift material is trapped and settled out.

(7) Vegetation

- Placement of structural material would cover existing aquatic vegetation. Resulting unavoidable turbidity during construction and maintenance periods would temporarily stir up some bottom sediments that would eventually settle out downdrift and cover some aquatic submergent plants.

- Installation of stone would provide long-term stable aquatic substrate for some forms of vegetation attachment on the submerged portion of the breakwater (algae). Calmer aquatic habitat in the leeward side of the breakwater may contribute to a more stable aquatic environment in this locale, which could alter the existing submerged aquatic community adversely or beneficially.

(8) Air Quality

- There would be some temporary, unavoidable, adverse impact on air quality due to increase in dust and odor during use of any construction equipment at the time of project implementation and during maintenance periods.

(9) Water Quality

- Temporary increase in water turbidity would occur during construction and maintenance periods.

- Some temporary unavoidable spillage of fuel, oil, and grease during construction and maintenance activity by heavy equipment may occur.

- Some water quality degradation may occur if pollutants accumulate in the calmer water zone between the breakwater and the shoreline.

(10) Nekton & Plankton

- No significant impact on plankton is anticipated, although construction and maintenance activity could displace or destroy some passively floating or free-swimming minute plant-animal life in the water.

(11) Terrestrial Soils and Bottom Substrate

- Depending on how far breakwaters are constructed offshore, there could be some buildup of beach substrate material along the shallow aquatic zone where water interfaces with the terrestrial bank. Wave attenuation caused by the structure and beach material buildup would help reduce the rate of erosion of terrestrial bank soils.

- Installation of stone fill material would cover existing substrate at the immediate site of the breakwater structure.

- Wave attenuation and entrapment of littoral drift material would continuously add to buildup of lake bottom substrate, and could cause some sand starvation alongshore at a downdrift area.

- Bottom substrate composition in the general vicinity of the breakwater and downdrift would be subjected to some continuous change.

(12) Topography

- Change in lake bottom relief would occur due to entrapment of littoral drift material at the breakwater, beach material accumulation inshore and, possibly sand starvation in some downdrift areas.

(13) Federal/State Fish and Wildlife Areas

- Coordination with fish and wildlife agencies would be maintained to avoid conflict with any existing or proposed management plans.

d. Other Environmental Criteria.

(1) Erosion

- The sheltered shoreline behind the offshore breakwater would receive increased protection from wave and wind erosion.

- There could be some loss of terrestrial shoreline soils downdrift of the project site.

(2) Sedimentation

- There would be an increase in accumulation of trapped littoral drift material settling out behind breakwater structures.

(3) Water Levels & Flows

- No significant noticeable impact on water levels would be anticipated.

- Some diversion or change in existing lake flows at the breakwater site and in the protected water behind the structure would probably occur.

(4) Productivity

- Existing productivity of aquatic organisms would probably be disrupted or destroyed at the project site where breakwater stone is placed to cover the bottom substrate, where trapped littoral drift material settles out and, at any benthic or terrestrial shoreline sites downdrift that may be indirectly scoured or eroded resulting from installation of such a structure.

- Productivity for some fauna and flora may decrease or increase in the sheltered water zone and along the protected terrestrial shoreline bank behind the structure.

- Aquatic habitat created by an increase in irregular, vertical, and horizontal sumerged area created by deposition of stone, could potentially improve productivity for some species of aquatic fauna and flora at the site - depending on the site's productivity prior to construction. The variety of gaps around placed stones could improve nesting, feeding, and cover habitat for some cavity dwelling fish species. Long-term stable habitat provided by stone would serve as attachment surfaces for growth of aquatic plants (e.g., Cladophora) and as habitat for invertebrates.

e. Economic Criteria.

(1) National Economic Development

- Recreational activities would be encouraged by the construction of offshore breakwaters. Both recreational beach use and boating will be enhanced by offshore breakwaters. The breakwaters would encourage small-boat harbors by reducing wave energy and allowing safer navigation and mooring.

- The value to national output due to increased recreational beach use and boating is based on willingness to pay for each increment of supply provided. Willingness to pay includes entry and

use fees actually paid for site use plus any unpaid value (surplus) enjoyed by consumers. Only payments for site use are to be measured under willingness to pay.

- Offshore breakwaters can provide flood and erosion protection by reducing the impact of wave energy reaching the shoreline. Benefits to the national output accruing due to protection are reduction in physical damages to buildings, contents, and public facilities, reduction in income losses sustained during flooding, and reduction in emergency costs such as police and fire protection during flooding.

- Benefits to unemployed or underemployed resources during the construction period are accrued.

(2) Local Government Finance

Taxes - The encouragement of recreational beach development and boating facility improvement and construction will result in larger tax yields. Potential increase in sales revenues due to beach recreationist's expenditures on food, lodging, and automobile services will increase local sales tax revenues. Boat recreationists will also provide potential increase in sales tax revenue by annual expenditures on dockage, gasoline, and boat maintenance. Additional sales taxes would be generated from sale of food and other goods and services to the boaters.

- An increase in tax collection will occur as the shoreline is claimed for more intensive land use purposes.

Property Values - The impact of breakwater construction will have a more immediate effect on the property values than tax collections. This is due to the lag between time when property values change and tax assessments are adjusted. These values can be expected to increase over time by the annual growth rate. Enhancement of property values due to flood protection will also occur.

Public Facilities - Breakwaters could result in increased benefits due to protection of electricity, gas, power, water and sewage, and transportation facilities. Public facilities downdrift of breakwaters could be adversely impacted due to erosion in downdrift areas.

Public Services - Significant impacts if induced commercial and residential development. Commercial recreational facilities would require an increase in public sewage and water treatment services. There would be a need for sewer and water services and other utilities as residential land use develops.

(3) Regional Economic Development

Real Income Distribution - Breakwaters result in increasing participation in outdoor recreation. Income to suppliers of goods and services such as travel, equipment, lodging expenses, and other items will increase

due to expenditures by recreationists. In certain areas, the tourist expenditures may well be the livelihood of local residents. Additional capacity will be needed to meet growing demand in the shoreline counties in swimming and boating activities.

- Some of the recreationist's income is used to buy goods and products produced locally. Some of that income is used to pay wages, salaries, profits, interest, and rents to members of the local community.

- Project implementation would result in income to unemployed and underemployed resources.

Employment/Labor Force - Recreationists demand local goods and services which results in employment opportunities in the local economy.

Business/Industrial Activity - Increased sales of retail business establishments due to recreationists and summer home ownership. Increased sales of commercial establishments related to beach and boating activities.

Agricultural Activity - May reduce the quality of soil in the downdrift areas and reduce the agricultural productivity. Displacement of farms could occur if commercial and residential land use increases.

7.3.6 LAKE LEVEL REGULATION

a. Social Criteria.

(1) Population Density

- Provided erosion protection and corresponding potential for increased shoreline development would probably result in an increased population density along the shoreline, primarily in development oriented shoreline areas. However, degree of development may be subject to local and State control policies such as State and county coastal zone management plans.

(2) Population Mobility

- Construction, provided shoreline protection, and increased development may result in furthering opportunities for population movement into and out of the coastal zone area.

(3) Housing

- Provided shoreline protection may result in stimulating housing opportunities.

(4) Displacement of People

- There may be possible displacement of people if land is required for access to, or construction of, new protective

structures, modifications of existing control structures, or need for disposal sites.

(5) Transportation

- Implementation of this measure would probably increase channel width and depth and alter draft clearances.

- Increased flows may increase navigation and recreation boating (steering) difficulties.

- Lower lake levels and increased river flows could adversely impact port, recreational, and locking facility efficiency.

- Structural regulation would probably alter ship-loading capacities, which in turn could have impacts to other modes of transportation.

- This measure may have adverse impacts to access routes or bridge structures.

- Reduction in lake water level may create or expose navigation hazards.

(6) Desirable Community Growth

- Lake level regulation may induce, protect, or provide for further shoreline developments; in turn, increased shoreline developments could necessitate creation or expansion of community services and facilities.

- Regulated decrease in the lake level would contribute to a decrease in shore damages along the lake coastline, which could stimulate community development. Increase in St. Lawrence River flow could increase shoreline erosion and adversely impact existing shoreline land use.

- Increase in lake level could benefit port communities by increasing shipping volume and trade. Increased vessel size that may be stimulated by increased lake depth could stimulate need for port expansion.

- Lower lake levels could limit efficiency or capacities of harbors and facilities, to accommodate commercial or recreational vessels.

- Lake level manipulation could alter efficiency of existing shoreline protective and functional structures.

- Lake level regulation may require the least new construction relative to the area of shoreline protected.

(7) Aesthetic Values

- Regulation of lake levels and flows could significantly alter existing shoreline appearance. Increase in lake level could cover or reduce size of sandy beaches; decrease in lake level could expose mud flats and decaying organic material.

- Reduction in rate of shoreline erosion or flooding potential provided by a decrease in water level, could help protect some coastal areas considered to be aesthetically pleasing.

- Dredging, which may be associated with lake level regulation, would require disposal of dredged material into either open-lake, shoreline, or upland areas. Disposal into the open-lake would cause temporary turbidity and, disposal into shoreline or upland areas could be temporarily unsightly during construction activity, and until dredged material sites stabilize with vegetation growth.

- Provided shoreline protection may promote new developments that could significantly alter the existing view of the shoreline and lake.

(8) Institutional Dynamics

- Project development and maintenance would require interorganizational coordination and cooperation.

- Lake level regulation may alter land and water use views of various public and/or private interests.

- May require alternative management, planning, and facilitative measures relative to control of future developments.

(9) Health & Safety

- Lake level regulation would provide increased protection against erosion and flooding.

- Protection induced developments may subject the associated increased population to shoreline hazards.

- Increased protection provided by lake level regulation may create a false sense of safety from erosion and flooding in the community.

- Low lake levels may limit access, draft, and water circulation in many of the bays and inlets along the lake, creating navigation hazards and possible water stagnation. Additionally, odor and pathogenic problems may be created along new exposed shoreline areas that were formerly submerged.

- Lower lake levels may expose intakes and outflows of public or private water supply, sewage treatment, or drainage facilities. This could subject the public to new pollution problems and health hazards (e.g., decreased dilution at sanitary and storm sewer outlets, exposed private septic system drains).

- Lower lake levels and increased river flows may create navigation and swimming hazards and decrease the efficiency of existing protective structures.

- Exposed dredged materials at shoreline or upland disposal sites may temporarily be a health hazard and odor problem.

(10) Community Cohesion

- Provided improved protection to the shoreline could act as a community cohesive force.

- Lake level regulation may induce conflict relative to protection needs, costs, and future development interests.

- The construction process, resulting structure or structures, and altered shoreline characteristics, may impact upon normal community function, thus affecting community cohesion.

- Lake level regulation may be more beneficial in one lakeshore area than in another.

(11) Noise

- There would be temporary noise during construction (e.g., dredging, transport, and disposal operations) during maintenance periods at regulation structures.

- There may be noise relative to induced developments that may be stimulated by provided protection.

(12) Leisure and Recreational Opportunities

- Lake level regulation may provide opportunities for increased recreational development.

- Lower lake levels and increased river flows may limit use and efficiency of existing facilities.

- Lower lake levels may adversely affect shoreline recreation opportunities (e.g., ice fishing, shoreline fishing, boating).

- Lake level regulation may expand or decrease opportunities for access to fishing, boating, and beach areas.

b. Cultural Resources.

(1) Archaeological Sites

- Should the lake level be raised, archaeological sites may be inundated and sites along the new shoreline may be subject to erosion; conversely, if the water level is lowered, sites along the new shoreline may be subject to erosion.
- Structural modifications in the St. Lawrence River (which could be associated with a lake level regulation plan) may disturb archaeological sites.
- Increased outflow on the St. Lawrence River which could be associated with lake level regulation may cause sites to erode.

(2) Historical and Architecturally Significant Structures

- Should the lake level be raised, historic sites may be inundated and historic sites along the new shoreline may be subject to erosion; conversely, if the water level is lowered, sites along the new shoreline may be subject to erosion.
- Structural modifications in the St. Lawrence River (which could be associated with a lake level regulation plan) may disturb historical sites and/or architecturally significant structures.
- Lowering the lake levels may alter the visual aesthetics of historic sites.
- Increased outflows on the St. Lawrence may cause shoreline historic sites to erode.

(3) Submerged Cultural Resources

- If the lake level is lowered, submerged cultural resources may be subjected to erosion.
- Dredging along the St. Lawrence River may disturb or destroy submerged cultural resources.
- Increased outflows on the St. Lawrence River may cause damage to submerged cultural resources.

c. Biological Criteria.

(1) Wetlands

- Increased flows (which could be associated with lake level regulation) may scour some wetlands in the St. Lawrence River.

- Increase or decrease in lake level regulation would alter size and composition of existing wetlands along the shoreline, or destroy some wetlands.

- Disposal of dredged material could alter or destroy some wetland areas alongshore or on uplands.

- Lowering of lake levels could expose additional natural barriers that would help protect some wetlands from wave and ice scour.

- Lower water levels may cause a decrease in deepwater marsh communities and a reduction in wetland open-water areas.

- Decreased water levels may stimulate public or private diking to create new wetlands or to temporarily conserve some existing wetlands.

(2) Fisheries

- Dredging and disposal of dredged material in the St. Lawrence River may alter or destroy spawning, nursery, feeding, and cover habitat.

- High water levels may make it easier for fish to move between the lake and associated wetlands and tributaries needed by some fish species in their life cycle; conversely, low water levels would hinder or prevent fish mobility between such aquatic zones.

- Fish species sensitive to low lake levels may be adversely impacted (e.g., lake trout, whitefish, walleye, muskellunge, and northern pike eggs could be destroyed).

- Lowering of water levels could trap and destroy young fry.

- Lowering of lake water levels may benefit lamprey control to some degree.

- Increase or decrease in water levels could cause temporary or long-term alteration in abundance, distribution, diversity, and habitat of the lake's fishery.

(3) Wildlife

- With long-term increase in water levels:

  a. Existing shoreline habitats would be altered to some degree.

  b. Some improvement in wildlife habitat conditions could potentially occur. Studies done by Eugene Jaworski et al. (April 1969) entitled, Impact of Great Lakes Water Level Fluctuations on Coastal Wetlands mentions that "increased water depths

generally provide improved habitat conditions for invertebrates as well as for amphibians and reptiles which, in turn, increase the wetland use by pisciverous birds and predator fish."

- With long-term decrease in water levels:

  a. Overwintering survival rate of amphibians and reptiles could be adversely affected due to elimination or alteration of water depth in shoreline wetlands (e.g., amphibians and reptiles that overwinter beneath ice cover and are buried in the mud along the cattail open-water edges of marshes.

  b. Reduction in aquatic habitat offering variety to wildlife (such as in areas well interspersed with open-water pockets and emergent plants) could reduce diversity and abundance of wetland-dependent species. Terrestrial wildlife would gain nesting, cover, and feeding habitat, whereas wetland dependent species would experience some decrease in habitat.

  c. Lake shoreline wetlands are important to waterfowl as migration staging habitat. Decrease in water levels could reduce wetland quality, which may result in less use by waterfowl.

- Predator/prey relationships could be impacted to some degree. Potential formation of narrower emergent plant zones due to increased lake levels would reduce aquatic cover and render some species more vulnerable to predation.

(4) Threatened or Endangered Species

- Whether or not possible loss of significant habitat and disturbance to any threatened or endangered species would occur would be investigated through coordination with State and Federal fish and wildlife agencies during subsequent planning stages.

(5) Benthos

- Long-term reduction in lake water level would decrease the amount of shoreline submerged habitat for aquatic invertebrates; conversely, long-term increase in water level would increase the amount of shoreline submerged habitat;

- Decrease in bottom habitat alongshore would destroy and disrupt invertebrates in such habitats.

- Decrease in water level could temporarily disrupt life cycles of benthic invertebrates alongshore.

- There would be disruption of the benthic environment in dredging sites and dredge disposal areas; existing benthic habitat would be excavated out; temporary silt and sediment settling downdrift

during and after dredging would unavoidably cover some invertebrates.

(6) Littoral Zone

- Reduction in lake water level would probably reduce the total amount of shallow water along the shoreline (amount lost in any specific area would depend upon the existing slope of the shoreline bottom topography).

- If dredging is done in the littoral zone, increase in depth, resultant turbidity, disruption of bottom substrate, and sediment redistribution could significantly adversely impact organisms in such shoreline areas.

(7) Vegetation

- Long-term lower lake levels would probably result in a lakeward shift of vegetation zones leaving a drier zone along the landward edge that could likely revert from aquatic species to more terrestrial plants (e.g., sedge meadows, shrubs, and trees). Long-term increase in water levels would likely decrease the amount of sedge meadow, emergent marsh, shrub, and tree types along the shoreline.

- Long-term lower lake levels would probably result in loss of some habitat diversity (e.g., reduction in submergent and floating aquatic plants in favor of more extensive emergent plant growth); emergent aquatic growth may increase in river mouths and embayments.

- Long-term lower lake levels could favor an increase in vegetation density of aquatic emergent species along the shoreline; some of these species may help attenuate shoreline wave energy.

- Long-term decrease or increase in lake levels would change existing aquatic and terrestrial plant composition along the shoreline.

- If dredging and disposal are conducted in the littoral zone, loss or disruption of aquatic vegetation at these sites and to some degree downdrift, would be anticipated. If upland disposal sites are utilized for dredge material disposal, existing aquatic and/or terrestrial plants would be destroyed.

- Long-term lower lake levels may lower water levels in lake water dependent barrier beach marshes, thereby potentially encouraging denser emergent growth in such marshes; conversely, higher lake levels may create higher water levels in barrier beach marshes and decrease emergent plant growth in favor of floating and submergent plant species.

(8) Air Quality

- There would be some temporary, unavoidable, adverse impact on air quality due to increase in dust and odor during use of any construction equipment at the time of project implementation and during maintenance periods.

- There could be temporary adverse impact on air quality due to odor from decomposing organic material along exposed mud flats during periods of lake level lowering. Formerly submerged aquatic vegetation would experience die-off and decay.

(9) Water Quality

- Reduced lake level may cause increased die-off of vegetation. Resultant concentrated decomposition of plant material may temporarily contribute toward an increase in degradation of water quality alongshore - especially in areas of less water circulation.

- Reduced lake level would decrease shoreline erosion substantially. A reduction in erosion with decreased turbidity and clearer water may result in an increase in cladophora growth in nearshore areas.

- Temporary increase in water turbidity would occur during dredging construction and maintenance periods and during installation or modification of regulation structures.

- Some temporary unavoidable spillage of fuel, oil, and grease during construction and maintenance activity by heavy equipment may occur.

- Regulated outflow into the St. Lawrence River (which may be associated with lake level regulation) could beneficially or adversely impact water quality. Temporary increased flow may provide more flushing-dilution action of existing water pollutants in the river and more oxygen. Increased flow currents may cause settled bottom pollutants (e.g., oils, grease, toxic metals) to be resuspended and settled out at other downdrift areas.

- Decreased lake water level may increase concentration of pollutants at the mouth of some tributaries to Lake Ontario because of the reduction in flushing action that may be anticipated.

(10) Nekton & Plankton

- Reduced lake levels would prevent or inhibit access by nekton into shoreline areas from which water was removed or made shallower. Use of plankton as food by nekton would therefore either be unavailable or possibly more difficult to obtain.

(11) Terrestrial Soils & Bottom Substrate

- Reduction in lake level would expose formerly submerged bottom soil to climatic elements; increase in water levels would submerge additional terrestrial soils along the shoreline.

(12) Topography

- Increased water level would inundate some terrestrial shoreline lands; conversely, lowering of water level would expose formerly submerged shoreline bottom to more terrestrial-like conditions.

(13) Federal/State Fish and Wildlife Areas

- Coordination with fish and wildlife agencies would be maintained to avoid conflict with any existing or proposed management plans.

d. Other Environmental Criteria.

(1) Erosion

- Lower lake level regulation would contribute toward a reduction in terrestrial shoreline erosion along the lake due to wave action.

- Increased flows (which may be associated with lake level regulation) may contribute to increased shoreline scouring in the St. Lawrence River.

(2) Sedimentation

- Increase in river flow would probably transport suspended sediments further downdrift before such material would settle out; conversely, reduction in flow would probably cause suspended material to settle out sooner.

(3) Water Levels and Flows

- If the existing 1958D regulation plan is left unchanged, the volume of release and timing of release as presently provided in this plan would be unchanged.

- If the existing 1958D regulation plan's control structure was not physically modified, but if new changes in water volume release and timing of release within the existing channel capacity of the St. Lawrence River were adopted, changes to water levels and flows in Lake Ontario and the St. Lawrence River would be anticipated.

- If changes to regulation under varying increases in channel capacity (due to excavation and dredging) were adopted, changes in levels and flows within the St. Lawrence River would be anticipated.

(4) Productivity

- There would be an impact on aquatic plant-animal biomass production within the littoral zone if lake water levels are decreased. Alteration of aquatic habitat from a wetter to a drier environment would change community composition; production of aquatic floating and submergent plants would likely decrease due to loss of submerged habitat; production of aquatic emergents and more terrestrial plants (shrubs, trees) may increase. The reverse would probably occur if water levels are raised.

- Existing benthic organism productivity would be destroyed or disrupted by excavation at dredging sites in the St. Lawrence River. Also, if dredged material is disposed of into alongshore diked disposal sites, existing benthic organisms at those sites would be covered. If upland disposal sites are selected, existing flora could be destroyed by covering with dredged material and some small species of fauna would either be displaced to surrounding areas outside the disposal site, or they could be destroyed by covering or unavoidably crushed by heavy construction equipment.

e. Economic Criteria.

(1) National Economic Development

- The regulation of lake levels has an impact on the municipal and industrial water supply, agricultural irrigation, hydropower production, commercial navigation, recreational navigation, recreation and urban flood damage.

- High lake levels benefit some categories of the NED account while adversely affecting other categories. Low lake levels will also have varying impacts on the activities cited. The excavation of channels may also be required to achieve necessary flows.

- High lake levels will increase urban flood damages and adversely affect the national output through physical damages, income losses, and emergency costs due to flooding.

- The availability of water is beneficial to irrigation activities only if the land is not flooded by higher lake levels. Hydropower is dependent on the higher lake levels and minimum flow levels. For example, irrigation withdrawals upstream could hinder the hydropower production downstream. Commercial

navigation and recreational navigation benefit from high lake levels due to increased ease of mooring and navigability. Deep-draft vessels employing the St. Lawrence Seaway would be adversely affected by the lower lake levels. Recreational beaches will benefit by lower lake levels since the beaches will be wider and provide a larger beach supply area. The municipal and industrial water supply intake structures will benefit from higher lake levels.

- Another aspect of lake regulation is the cubic feet per second (cfs) flow. Minimum flow levels are required to provide adequate hydropower production, agricultural irrigation, and safe navigation.

- The excavation of channels in the St. Lawrence River would improve navigation by providing minimum cfs flow and deeper water for the St. Lawrence Seaway vessel traffic.

(2) Local Government Finance

Taxes - Tax collection will increase to the extent that lake level management provides flood and erosion protection.

Real Property Values - Lower lake levels would tend to induce development along the shoreline and enhance existing development by allowing the expansion of recreational beaches. The total value of structures along the shoreline is $78,258,900 and the total value of land is $26,861,000. Both the value of land and structures will grow as the shoreline is urbanized.

Public Facilities - The lower lake levels would result in increased protection for the physical structure by reducing damages but would adversely affect the efficiency of the operation of water intake structures and sewer outfall structures. The overall effect would depend on the location of the physical structures to the lake.

Public Services - The provision of water and sewerage treatment would be improved with higher lake levels.

- Adverse impacts to higher lake levels are emergency police and fire protection costs during flooding.

(3) Regional Economic Development

Real Income Distribution - The expansion of commercial and recreational activities due to lower lake levels would expand the income sources for the local community. The new and expanded businesses provide wages to the local populace.

- Income is garnered by suppliers of goods and services such as travel, equipment, lodging expenses, and other items due to expenditures by recreationists. Some of that income is used to buy goods and products produced locally and some is used to pay

wages, salaries, profits, interest, and rent to the members of the local community.

Employment/Labor Force - Flood protection due to lower lake levels would induce commercial development and provide employment opportunities. Recreationists demand local goods and services which results in expansion of employment opportunities in the local economy.

Business/Industrial Activity - Increased sales of retail business establishments due to recreationist expenditures. Increased sales of commercial establishments related to park activities.

- Induced commercial development as a result of reduced flood damages.

Agricultural Activity - Displacement of farms could occur if the shoreline becomes increasingly urbanized. Low lake levels will curb erosion of productive farmland while adversely affecting the irrigation of the lands.

7.3.7 FLOODPROOFING

a. Social Criteria.

(1) Population Density

- This measure utilizes protection of individual structures or complexes of structures to reduce flood damages and, may be individually initiated or required through building codes. It generally increases construction costs and is usually required to obtain flood insurance. So, depending on community interest and values toward developing in the flood plain, population and new structure density could either increase or decrease.

(2) Population Mobility

- If the local governing body selects the floodproofing measure, restrictions on new structure construction may or may not be a part of that decision; this decision could have either an adverse or beneficial impact on the community by either encouraging or discouraging population egress or regress out of or into the flood plain to some degree.

(3) Housing

- Increased expense to floodproof existing or future structures could impact on housing opportunity in the flood plain.

- This measure would provide limited protection to existing or future structures in the flood plain.

(4) Displacement of People

- Some existing flood plain residents may decide to move from the community instead of expending money to floodproof.

Transportation

(5) . Generally, floodproofing would not protect transportation routes during time of flooding.

(6) Desirable Community Growth

- Generally, floodproofing does not provide complete flood protection to structures, contents, and residents. Storms of higher intensity (above design flood frequency) could still cause problems; flooding of lower magnitude would still create siltation and scouring problems in unprotected areas of the flood plain. This could tend to reduce the rate of community growth.

- Floodproofing could tend to restrict types of developments, since expense to floodproof large flood plain structures may be unacceptably high to some people.

- Even with floodproofing of structures, maintenance of community facilities and services would still be required.

- Depending on community goals and values, rate of development could be restricted or promoted if floodproofing measures are adopted.

(7) Aesthetic Values

- Floodproofing measures, whether temporary or permanent, may be considered as unsightly by some people. However, some types of floodproofing could be installed to appear more aesthetically acceptable.

(8) Institutional Dynamics

- Program enforcement of floodproofing measures could be difficult.

- This measure may raise conflict of interests over alternative protection measures and individual or community responsibility and development.

- Complex patterns of land and building ownership could present problems in coordination and cooperation in setting up and implementing floodproofing measures.

- Increased protection provided by floodproofing could potentially stimulate further development or sale of property or they may contribute toward hindrance of development and sale of property.

(9) Health & Safety

- Floodproofing would provide a limited degree of flood protection.

- A false sense of total safety to residents from flooding may subject existing and potential future increased population to shoreline or flooding hazards.

- Limited protection provided to community facilities and services may induce health and safety problems, if floods greater than the design frequency for which flood protection is provided occur. Although structures in the flood plain would be protected, there could still be drainage problems in unprotected areas of the flood plain and, perhaps potential flood-related sewage problems to some degree.

(10) Community Cohesion

- Floodproofing may induce conflict relative to protection needs, cost, and future development interests.

- Partial floodproofing would not protect all facilities and services during times of flooding and, some normal community functions would be disrupted.

- Awareness of a sense of security from frequent flooding may act as a cohesive force.

(11) Noise

- Unavoidable construction noise would occur during floodproofing installation and maintenance periods.

(12) Leisure, Cultural, and Recreational Opportunities

- A floodproofing program would probably stress use of the flood plain for low damage developments, emphasizing recreational-type open-space developments.

b. Cultural Resources.

(1) Archaeological Sites

- Since floodproofing consists of adjustments to structures and building contents, no earth excavation is generally anticipated. However, if low levees are constructed around structures, archaeological sites could be disturbed.

(2) Historical and Architecturally Significant Structures

- Floodproofing of historic buildings may introduce architecturally incompatible components that alter the existing historic integrity of a structure.

- Historic structures could be given increased protection from flood damage to inferior contents, provided that floodproofing measures are compatible with the original architectural style.

(3) Submerged Cultural Resources

- Since floodproofing would consist of adjustments to existing or new buildings and contents to reduce flood damages, no significant impact on cultural submerged resources would be anticipated.

c. Biological Criteria.

(1) Wetlands; (2) Fisheries; (3) Wildlife; (4) Threatened or Endangered Species; (5) Benthos; (6) Littoral Zone; (7) Vegetation

- Generally, no significant impacts on these resources are anticipated if floodproofing adjustments to existing structures and building contents are implemented.

- If floodproofing is done during the wildlife breeding, nesting, or brooding season, temporary noise and human activity associated with this measure may cause some species of fauna to avoid nearby habitats until such activity terminated. If low levees around structures are installed, some disruption to terrestrial wildlife habitat may occur.

(8) Air Quality

- Temporary noise activity during exterior floodproofing of existing structures would probably occur.

(9) Water Quality; (10) Nekton and Plankton; (11) Terrestrial Soils and Bottom Substrate

- Generally, no significant impacts on these resources are anticipated if floodproofing adjustments to existing structures and building contents are implemented. If low levees around structures are installed, some disruption to terrestrial soils would occur.

(12) Topography

- Generally, no significant impacts on existing terrestrial relief are anticipated if floodproofing adjustments to existing

structures and building contents are implemented. If low levees around structures are installed, some change in vertical and horizontal relief would occur.

(13) Federal/State-Owned Natural Areas

- No significant impacts on existing Federal/State-owned natural areas are anticipated. Coordination with Federal and State natural resource agencies would be maintained to avoid conflict with existing or potential management plans.

d. Other Environmental Criteria.

(1) Erosion, (2) Sedimentation, (3) Water Levels and Flows, and (4) Productivity

- Generally, if floodproofing adjustments to existing structures and building contents are implemented, no significant impacts with regard to the above criteria would be anticipated. If floodproofing adjustments to building exteriors occur during the wildlife breeding season, noise associated with floodproofing activity could temporarily disturb some nesting wildlife near such buildings. If low levees around structures are installed, soil disrupted by heavy equipment could be temporarily subject to more erosion from surface runoff until planted vegetation became established to reduce the rate of runoff. If levees are placed in good vegetation cover, there may be some elimination of habitat, or reduction in quality of nesting, feeding, or cover habitat for wildlife.

e. Economic Criteria.

(1) National Economic Development

- Elevation of structures and use of water resistant materials and damage reducing construction practices can reduce potential damage to future structures. All flood damage reduction to buildings, contents, and public facilities are a direct benefit to national output.

- The reduction in flood insurance premiums due to floodproofing is a contribution to the NED account or an increase in the value of goods and services.

(2) Local Government Finance

Taxes - An increase in tax collections will occur as the residential and commercial land uses are expanded within the rules and regulations specified by the zoning ordinances.

Property Values - The effect of the floodproofing on property values can be an enhancement of property values. This would occur as a result of floodproofing measures.

Public Facilities - Sanitary sewerage backup during floods can be prevented by installation of a gate valve and by installing valves in floor drains.

Public Services - The emergency costs associated with flooding such as police and fire protection can be reduced with floodproofing of existing and future structures.

- The interruption of gas, water, and electricity services also incur additional costs to the community.

(3) Regional Economic Development

Real Income Distribution - The reduction in flood damages due to floodproofing measures such as the elevation of existing and future structures will raise the regional income as it reduces the income losses sustained during flooding. Protection by floodproofing will preserve contents of residential homeowners and inventory of local business concerns.

- The reduction in local emergency flood control costs will also be beneficial to regional income.

Employment/Labor Force - Floodproofing could reduce the number of emergency closure days due to flooding. The losses sustained by salaried employees is a direct loss to the regional income. The reduction in income losses due to the fewer emergency days is a direct benefit to the regional economic development account.

Business/Industrial Activity - The prevention of damages to commercial sales inventory is a direct benefit of floodproofing.

Agricultural Activity - No significant impacts are expected.

7.3.8 PUBLIC POLICY INDUCEMENTS (TAX ADJUSTMENTS AND COST-SHARING)

Note: It is possible that any or all of the shoreline structural or nonstructural measures previously addressed, could be implemented under a cost-sharing or tax adjustment policy. Therefore, the impacts previously mentioned would be applicable under this measure as well.

a. Social Criteria.

(1) Population Density

- If taxes were levied to limit development in hazard areas, population density in such areas would probably decrease.

- If taxes were decreased or levied to provide erosion and flooding protection or facilities, population density would probably increase.

(2) Population Mobility

- Some tax structure or change in tax structure may provide opportunity for population mobility.

- Since cost-sharing programs are generally based on widespread user benefits, user group developments (i.e., beaches, marinas), growth or new development of such facilities may be induced.

- Taxes waivered or deferred to encourage special types of developments in hazardous areas could potentially lessen financial burdens on property owners, making more funding available for relocation of people.

- Taxes tied to "best use" and/or "actual use" limit development or types of developments through increased taxes. The tax increases or potential tax increases resulting from development may encourage relocation. Persons desiring certain types of developments may look for better opportunities elsewhere.

- Cost-sharing programs may contribute toward inducing population mobility to some extent by lessening cost burdens to some degree, which could potentially provide some money for use in relocation.

(3) Housing

- Resulting protection or induced developments may provide opportunities for housing development.

- If taxes were levied to limit development and induced displacement of people were to occur, housing opportunities would probably require outside the hazard areas.

(4) Displacement of People

- No direct displacement of people would be anticipated by implementation of this measure. Indirectly, however, there may be some induced displacement of people because of any increased costs or because of inducted types of developments.

(5) Transportation

- If tax adjustment or cost-sharing encourages further development, it may indirectly induce a need for expansion of transportation facilities.

(6) Desirable Community Growth

- This measure may be used as a tool to induce or limit development or to provide an incentive to protect existing structures or future developments.
- Increased development could require expansion of community services and facilities.
- Cost-sharing may provide a fair way to distribute costs.

(7) Aesthetic Values

- Continued development would further encroach upon remaining open space and its natural aesthetic appearance along the shoreline. Conversely, a tax adjustment or cost-sharing policy that tends to limit development or decrease the rate of development would probably tend to conserve the existing open-space aesthetic appearance of the shoreline.

(8) Institutional Dynamics

- Program development to define and implement this measure would require interorganizational coordination and cooperation.
- Generally, increases in tax or cost-sharing policy generate conflict from tax or share payers.
- Regulation of development through taxation would probably create conflict among development interests.
- Implementation of this measure may require additional management, planning, and facilitative measures relative to future developments. A continual program to determine cost/benefit shares or taxes may be required.
- Conflict as to who should assume shoreline protection responsibilities and costs may develop as a major consideration in selection of this measure.

(9) Health & Safety

- This measure may provide a degree of safety to residents through protective measures provided.
- Continued development could subject increased population to shoreline flood and erosion hazards.
- Resulting protective structures could be hazardous.
- Resulting increased shoreline protection provided may give residents a greater feeling of safety from flooding and/or erosion.

(10) Community Cohesion

- Structural protection along the shoreline which may be promoted by this measure, may or may not contribute to community cohesion. Conflicts over protection responsibility, cost-sharing, and development interests would probably occur.

- Indirectly, this measure may limit who can afford to develop shoreline property.

(11) Noise

- If this tax adjustment provides for implementation of protective measures along the shoreline there could be temporary construction noise associated with installation of protective measures and during maintenance periods.

(12) Leisure, Cultural, and Recreational Opportunities

- The tax or cost-sharing policy selected may limit residential developments but could provide opportunities for recreational or leisure-oriented coastal shoreline uses.

b. Cultural Resources.

(1) Archaeological Sites

- Should a tax structure or cost-sharing policy be implemented which would discourage future development in flood plain areas, conservation of archaeological sites could be expected.

- If special protection districts are established, installation of structural protective measures along the coastline could adversely impact existing archaeological sites.

(2) Historical and Architecturally Significant Structures

- If special protection districts are established, installation of structural protective measures along the coastline could alter or destroy existing historical and/or architectural sites.

(3) Submerged Cultural Resources

- If special protection districts are established, installation of structural protective measures in aquatic environments along the coastline could alter or destroy submerged cultural resource sites.

c. Biological Criteria

(1) Wetlands; (2) Fisheries; (3) Wildlife; (4) Threatened or Endangered Species; (5) Benthos; (6) Littoral Zone; (7) Vegetation

- Tax adjustment and cost-sharing policies may be utilized to promote best use of coastal zone lands. This policy could - either directly or indirectly - promote conservation and less intensive use of significant shoreline resources - particularly, significant wetlands, terrestrial and aquatic wildlife habitats and vegetation zones, fisheries habitats (especially littoral zone and wetland spawning and nursery areas) and benthic organism habitats.

- If structural shoreline protection is chosen as part of the tax adjustment or cost-sharing program, it is possible that some short or long-term loss or disturbance to the aforementioned resources may occur.

(8) Air Quality; (9) Water Quality

- No significant long-term adverse impact on these resources is anticipated. If structural protection is chosen in a tax adjustment or cost-sharing program, some unavoidable short-term construction impacts would occur (e.g., noise, dust, and turbidity associated with heavy equipment activity).

(10) Nekton and Plankton; (11) Terrestrial Soils and Bottom Substrate; (12) Topography

- No significant adverse impact would be anticipated with regard to nekton, plankton, terrestrial soils and bottom substrate, and topography if shoreline structural protective measures were not included in a tax adjustment or cost-sharing program. However, if structural protection was included, short and long-term disturbance or alteration to the above resources would occur.

(13) Federal/State Fish and Wildlife Areas (Existing)

- Coordination with fish and wildlife agencies would be maintained to avoid conflict with any existing or proposed management plans.

d. Other Environmental Criteria.

(1) Erosion; (2) Sedimentation

- No significant adverse impact would be anticipated with regard to erosion and sedimentation if shoreline protective measures were not included in the tax adjustment or cost-sharing program.

However, if structural protection was included, some temporary erosion and sedimentation from disturbance to terrestrial soils and/or bottom substrate along the shoreline would be unavoidable.

(3) Water Levels and Flows

- No significant impact on existing lake water levels would be anticipated. However, depending on the type of shoreline protection structures under a tax adjustment or cost-sharing program selected, there could be some alteration in littoral flows.

(4) Productivity

- No significant adverse impact would be anticipated with regard to erosion and sedimentation if shoreline protection measures were not included in a tax adjustment or cost-sharing program. If structural protective measures were implemented along the shoreline, some adverse short and long-term impact on productivity of terrestrial and/or aquatic fauna and flora would occur.

e. Economic Criteria.

(1) National Economic Development

- The use of tax adjustments could contribute to national output by reducing undesirable development in flood hazard and erosion zones.

- The reduction in damages to structures in flood plain hazard area would be a direct contribution to national output.

(2) Local Government Finance

Taxes - The measure would tend to have an adverse impact on the tax base by discouraging extensive development.

- The use of higher taxes as an inducement to comply with coastal zoning laws will result in temporary influxes of tax revenue for local governments.

- Property owners will likely comply with zoning laws to avoid higher taxes. This will result in a reduction in revenues to the local governments in the long run.

Real Property Values - The adherence to zoning laws will assist in stabilizing the value of land and buildings.

- There would be relatively little changes expected in these values with tax controls in place to minimize the urban shoreline development.

Public Facilities - Tax adjustment measures would tend to reduce urban development pressures in the shoreline communities. The compliance with zoning ordinances is beneficial in that they can assure adequate provision of transportation, water, sewage, schools, parks, and other public requirements.

Public Services - Tax adjustment measures can assure development in areas which have availability of sanitary and storm sewers, water supply, and other utilities.

(3) Regional Economic Development

Real Income Distribution - Proper land use management through tax controls can serve to strengthen the local economy by reducing the cost of Government services for flood control and erosion protection.

Employment/Labor Force - Employment percentages could increase with the growth in commercial and recreational establishments in the shoreline communities.

Business/Retail Activity - The shoreline communities can regulate the development of future commercial activities through the use of tax measures. Development of commercial activities can be geared to the benefit of local residents.

Agricultural Activity - The preservation of prime agricultural land is a goal of the Lake Ontario Shoreline communities. Tax controls which enforce agricultural district zoning can assist in avoiding the displacement of farms.

7.3.9 PURCHASE/EASEMENTS

a. Social Criteria.

(1) Population Density

- Generally, this type of regulation would stop or limit types of development and probably would limit or decrease population growth and density.

(2) Population Mobility

- Generally, this type of regulation would require compensation which may indirectly provide opportunities for population movement to other areas.

(3) Housing

- This measure could provide for limited housing development in the purchase or easement area.

(4) Displacement of People

- Acquisition of title or rights of land in the coastal zone may result in direct or indirect displacement of people.

(5) Transportation

- Generally, implementation of this measure would tend to limit development of transportation facilities.

(6) Desirable Community Growth

- Generally, this measure would tend to limit shoreline residential development; it may provide for community-type developments (parks, etc.).

- This measure is expensive and would probably limit the local tax base.

(7) Aesthetic Values

- Since purchase and easements would be applied to undeveloped land, which because of development pressures have a high likelihood of development in the future. Such a program would tend to conserve the existing aesthetic appearance of significant open-space areas.

(8) Institutional Dynamics

- Development and implementation of this measure would require interorganizational coordination and cooperation at the local level.

- Purchase and easements may require alternative management, planning, and facilitative measures relative to future development.

- This measure may limit opportunities for development interests if private lands are acquired and taken out of the development market.

(9) Health & Safety

- Directly, purchase and easements on undeveloped land would limit or preclude future development from occurring in such areas. Indirectly, this would prevent expansion of flooding impacts to new structures and threat to human health and safety on coastal lands covered by this measure.

- Conflict may arise as to protection responsibilities that should or should not be provided by this measure. For example, should

riparian land owners provide their own protection; should special taxes be levied on riparian land owners so that the town can provide protection; or, should general taxes be used to provide protection (where and at what level - Federal, county, local).

(10) <u>Community Cohesion</u>

- Protection policy selected in this measure and inducive community-type developments may act as a cohesive or polarizing force in the community.

- Purchase or easement rights may cause possible displacement of people from some affected lands.

(11) <u>Noise</u>

- Generally, this measure is used as a positive method to regulate types and degree of development. Noise impacts normally associated with the type and degree of developments permitted, would be temporary.

(12) <u>Leisure, Cultural, and Recreational Opportunities</u>

- This measure could provide opportunities for recreational or leisure-oriented shoreline uses and,

- Possibly increased public access to such shoreline use areas.

b. <u>Cultural Criteria</u>.

(1) <u>Archaeological Sites</u>

- The limitation of development within the purchase or easement area would enhance the probability of conservation of archaeological sites.

(2) <u>Historical and Architecturally Significant Structures</u>

- The subsequent abandonment of historic and architectural structures after purchase could tend to accelerate deterioration and increase vandalism.

- Significant historic or architectural structures may be lost if their purchase results in removal.

(3) <u>Submerged Cultural Resources</u>

- Since this measure is applied to undeveloped land, no significant impact on submerged cultural resources is anticipated.

c. <u>Biological Criteria</u>.

(1) Wetlands; (2) Fisheries; (3) Wildlife; (4) Rare and Endangered Species; (5) Benthos; (6) Littoral Zone; (7) Vegetation; (8) Air Quality; (9) Water Quality; (10) Nekton and Plankton

- Although this measure could provide limited housing development in the purchase or easement area, it would be most applicable to undeveloped land (e.g., wetlands) which, because of development pressures, have a high likelihood of being destroyed. Implementation of this measure would contribute toward conserving significant coastal zone lands for future generations.

- Decreased or no permitted development on coastal zone lands would reduce potential for man-made construction impacts on terrestrial and aquatic shoreline fauna and flora communities, as well as associated temporary construction impacts on air and water quality.

(11) Terrestrial Soil and Bottom Substrate

- Terrestrial soils may be unavoidably disturbed on sites if limited development is permitted. No significant impact on submerged bottom substrate along the shoreline would be anticipated.

(12) Topography

- Existing topography may be altered at sites from which purchased structures are removed, or at sites where limited development is permitted.

(13) Federal/State-Owned Natural Areas

- No significant impacts on existing Federal/State-owned natural areas are anticipated. Coordination with Federal and State natural resource agencies would be maintained to avoid conflict with existing or proposed management plans.

d. Other Environmental Criteria.

(1) Erosion; (2) Littoral Zone

- Acquisition of title or rights of land within the coastal zone would tend to limit or prevent development on such areas and, therefore, reduce erosion potential due to man-made construction impacts as well as associated sedimentation from such construction into the littoral zone.

(3) Water Levels and Flows

- No significant impact on water levels and flows would be anticipated if this measure were implemented.

(4) Productivity

- Since development on lands under purchase or easements would be either limited or prevented, potential for disturbance to wildlife amd associated habitat during the breeding season would probably be less. However, if purchased structures are removed or if limited development is allowed on some coastal zone lands during the breeding season, disturbance to wildlife may cause nest destruction or abandonment due to heavy equipment activity.

e. Economic Criteria.

(1) National Economic Development

- Purchases and easements could contribute to recreational value by preserving natural wildlife areas and other recreational sites.

- Adverse impacts of the plan would be the elimination of development in areas purchased by acquisition of title and/or rights by voluntary means or via condemnation or eminent domain.

(2) Local Government Finance

Taxes - To the extent the purchases and easements prevent development, the potential tax collections will be reduced.

- Preservation of wetlands and other environmentally sensitive areas would stabilize the tax base.

Real Property Values - Development easements would most likely reduce the value of the property.

- There could be an enhancement of property values for land areas near the wetlands, preserved wildlife areas, and recreational sites.

Public Facilities - Facilities to areas which would normally have required facilities for future development would be reduced. Public access sites and transportation facilities could be developed as a result of public land purchases. This would, in turn, enhance the recreational value and may require future public facilities.

Public Services - Recreational sites preservation could attract recreationists. The increased recreational activity could result in an expansion of commercial recreational activities.

- Public ownership would increase the opportunity for providing additional services for the community and region.

(3) Regional Economic Development

Real Income Distribution - An increase in recreational activity will provide an added source of income to the community. Income is garnered by suppliers of goods and services such as travel, equipment, lodging expenses, and other items due to expenditures by recreationists. Some of the income is used to buy goods and products locally while some is used to pay wages, salaries, profits, interest, and rents to members of the local community.

Employment/Labor Force - Recreationists demand local goods and services which results in expansion of employment opportunities in the local economy.

Business/Industrial Activity - Increased sales of retail business establishments due to recreationists. Increased sales of commercial establishments related to park activities.

Agricultural Activity - The displacement of farms would be reduced with the reduction of development pressures and inducements for nondevelopment.

7.3.10 EVACUATION/RELOCATION

a. Social Criteria.

(1) Population Density

- Since structures and people would be removed from problem areas, population density in the immediate problem area would decrease; conversely, population in other areas would increase.

(2) Population Mobility

- The Setback-Relocation measure would require relocation of people to other areas.
- This measure generally would provide some degree of financial compensation which would contribute toward providing opportunity for population mobility out of the problem area.
- There would probably be both local willingness as well as resistance to relocation of buildings and movement of people from existing erosion or floodprone areas.

(3) Housing

- This measure could totally or severely limit housing opportunities in the designated problem area; it would require that housing opportunities be available within a reasonable distance outside the problem area - particularly since some residents may have strong ties to their existing homes, lands, and places of employment.

(4) Displacement of People

- This measure would probably result in direct displacement of people from problem areas to new locations.

(5) Transportation

- This measure would probably require some rerouting and reconstruction of local transportation facilities; it may also limit future development of such facilities in the vicinity of erosion or floodprone areas.

(6) Desirable Community Growth

- This measure could disrupt the existing community growth pattern.

- This measure may severely limit types of developments in problem areas.

- This measure may necessitate removal of some existing community services and facilities from problem areas and, reorganization of such services and facilities to newly relocated homes and residents.

(7) Aesthetic Values

- Relocation of buildings may significantly alter the lake view now presently enjoyed by residents living on such existing shoreline properties.

- Relocation of buildings onto other sites more inland would alter existing appearance of such sites (e.g., some open lands would become developed).

- Abandoned structures, if not removed, would deteriorate and become unsightly along the shoreline.

(8) Institutional Dynamics

- This measure would require local coordination and cooperation to be effective.

- It could create conflict relative to development rights and personal interests.

- It could alter governmental or private service responsibility and area of jurisdiction within which such services could be provided.

- This measure may cause relocation of some institutions in the shoreline vicinity.

(9) Health & Safety

- This measure would provide increased protection to structures and residents by limiting exposure to existing or potential hazards (flood, erosion, pathogenic disease, etc.).
- Relocated residents would probably feel an increased sense of security from flooding or erosion.
- This measure may require relocation of services or facilities.
- Abandoned unremoved structures may be a safety hazard.

(10) Community Cohesion

- Displacement of people and resulting disruption of community ties and function would probably adversely affect community cohesion if this measure was implemented.
- Protection provided by this measure and limited or no development may act as a cohesive force to some people; however, conversely, interest in promoting development may act as a cohesive force to other people interested in shoreline property.

(11) Noise

- Removal or relocation of structures would cause temporary noise along the shoreline.

(12) Leisure, Cultural, and Recreational Opportunities

- Limitation of residential developments may be conducive to stimulating use of such shoreline areas for outdoor recreation or as natural areas.

b. Cultural Resources.

(1) Archaeological Sites

- Structures which are relocated to new land areas may disturb archaeological resources at both the previous and new structural site.

(2) Historical and Architecturally Significant Structures

- If this measure is implemented, relocated historic building would probably lose their historic integrity by no longer being associated with the area which gave them significance. Historic buildings may be abandoned and subsequently deteriorate if they are not maintained.

(3) Submerged Cultural Resources

- Since setbacks and relocations involve the actual movement of existing structures from erosion and/or floodprone areas on terrestrial lands, no significant impact on submerged cultural resources would be anticipated.

c. Biological Criteria.

(1) Wetlands; (2) Fisheries; (3) Wildlife; (4) Threatened or Endangered Species; (5) Benthos; (6) Littoral Zone; (7) Vegetation

- In general, there would probably be some reduction in pressure exerted on these resource criteria from human activity after structures are relocated. If setback-relocation disturbance occurs during the fauna breeding season, temporary noise and human activity associated with this measure may cause some species of fauna to avoid nearby aquatic or terrestrial habitats until such activity terminated. Relocation of buildings to other open terrestrial land areas may destroy or disrupt wildlife habitat at such new sites. Use of heavy equipment to remove and relocate structures may temporarily destroy vegetation cover around structures (as well as on new sites). Until planted or natural vegetation was restored, temporary siltation or runoff into the littoral zone may occur alongshore.

- More open land may be gained along the shoreline if this measure is implemented.

(8) Air Quality

- During relocation of structures, use of heavy construction equipment would unavoidably cause some dust, odor, and vehicle emissions.

(9) Water Quality

- No significant deteriorating effect on water quality would probably occur. Relocation of existing residential buildings alongshore to terrestrial lands further back from shore may decrease shoreline pollution, since private septic systems would probably have to be improved to meet health department standards, where needed, prior to discharge lakeward.

(10) Nekton and Plankton

- No significant impact on nekton or plankton is anticipated if this measure is implemented, since relocation activity would principally apply to terrestrial lands.

(11) Terrestrial Soils and Bottom Substrate

- Terrestrial soils would be unavoidably disturbed by heavy equipment at sites where structures are removed and at sites where they are relocated.

- If structures are relocated onto agricultural lands formerly left idle or used for grass or grain crops, some prime or unique farmland could be removed from active use.

(12) Topography

- Existing topography may be altered at sites from which structures are removed and, at sites upon which structures are relocated.

(13) Federal/State-Owned Natural Areas

- No significant impacts on existing Federal/State-owned natural areas are anticipated. Coordination with Federal and State natural resource agencies would be maintained to avoid conflict with existing or potential management plans.

d. Other Environmental Criteria.

(1) Erosion

- If actual movement of structures from problem areas occurs, soils disturbed by heavy equipment activity (e.g., removal of existing vegetation, excavation, etc.) may erode, unless such areas are promptly protected to reduce soil loss.

(2) Sedimentation

- Land disturbed during removal of structures along the shoreline may contribute sedimentation to the littoral zone during surface runoff periods, unless such lands are promptly protected to reduce soil loss.

(3) Water Levels and Flows

- No significant impact on water levels and flows would be anticipated if this measure were implemented.

(4) Productivity

- If existing structures were moved from erosion and floodprone areas during the wildlife breeding season (e.g., May - July), heavy equipment activity and noise associated with moving could temporarily disturb and displace nesting species near such activity areas. It is also possible that movement of existing

structures to new land areas during that season could destroy some bird and small mammal nests at new structural relocation sites.

e. Economic Criteria.

(1) National Economic Development

- Benefits to national output accrue to the relocation measure in that flood damage is eliminated and no residual damages are incurred.

- Benefits include cost savings to nonusers, for example, Federal Flood Insurance subsidies, emergency evacuation, and other public savings.

- Setback measures will reduce the erosion threat to private and public structures. The rate of depreciation of the value of commercial and residential structures would decrease as the setback distance increases. The preservation of property (public and private) along the shoreline is a benefit to national output.

(2) Local Government Finance

Taxes - The relocation of structures will result in shifting of the tax base. The total tax collection change will depend on whether or not property is relocated to a setting where real property taxes are higher.

- The setback measure will assure a continued stabilized tax collection by reducing the likelihood of existing shoreline properties being claimed by erosion.

Real Property Values - Enhanced property values due to flood and erosion protection.

- The depreciation of commercial and residential structures would decrease due to increased setback distances.

- There will be a decline in property values in sites where the structures have been removed.

Public Facilities - The relocation of property could result in overall losses to public facility efficiency.

- The relocated structures will place additional stress on facilities in the new areas while there is a decreasing demand for these facilities in the flood hazard areas.

- The additional costs to relocation and demand for facilities are an adverse impact of this plan.

Public Services - In general, the additional costs of supplying services to newly relocated structures is an adverse impact of the relocation measure.

- The emergency costs associated with flooding such as police and fire protection would be reduced when setback and relocation measures are implemented

(3) Regional Economic Development

Real Income Distribution - The setback and relocation methods are considered to be among the most effective methods of reducing future erosion and flooding damages.

- These methods can serve to strengthen the local economy by reducing the cost of Government services for flood control and erosion protection.

Employment/Labor Force - Redistribution of labor force if workers are relocated to areas too far away from their source of employment.

Business/Retail Activity - The prevention of damages to commercial structures and contents is a direct benefit of relocation.

- Setback distance increases will reduce the depreciation of commercial structures.

Agricultural Activity - Displacement of farms could occur if rural land is urbanized to relocate flood plain homeowners.

7.3.11 FLOOD/EROSION INSURANCE

a. Social Criteria.

(1) Population Density

- This measure would not necessarily preclude continued development in hazardous areas; consequently population density in flood plain and erosion-prone areas may continue to increase.

(2) Population Mobility

- Certain aspects of the flood insurance program (namely purchase and removal of structures sustaining repeated damage and/or regulation of development and redevelopment in hazard areas by requiring built-in protection measures which would generally increase construction costs), would discourage people from remaining or moving into a hazard area and encourage movement of people from hazard areas.

- Compensation for damages incurred may provide incentive for movement of some residents out of the hazard area.

(3) Housing

- Development restrictions associated with an insurance program may limit housing opportunities in the hazardous area. Need for housing outside of the hazard area could increase.

(4) Displacement of People

- No direct displacement of people would occur with implementation of this measure.

- Restrictions on future construction in hazardous areas (which may be associated with this measure) induces displacement of people.

(5) Transportation

- Implementation of an insurance program may restrict development and need for development in hazard areas.

- Flood/erosion insurance would not protect transportation routes and facilities from hazards.

(6) Desirable Community Growth

- As long as structural protection standards required in flood and erosion insurance are met, development may continue in hazard areas.

- This measure would induce a requirement for structural flood protection measures on new developments. Such a requirement would help reduce serious flood damage to such new structures in the future.

- Continued development in hazard areas may require the expansion and increased maintenance of community facilities and services.

(7) Aesthetic Values

- Structural protection to buildings may be aesthetically unpleasing.

- New development projects may adversely effect the existing aesthetic appearance and view of the area.

(8) Institutional Dynamics

- Insurance program development requires interorganizational coordination and cooperation.

- This measure may alter views and interests of various organization and interest groups.

- Implementation of the insurance measure would require alternative management, planning, and facilitative measures relative to future developments.
- This measure may help alleviate some relocation or displacement problems. It could be applicable to more than a local level.
- There may be difficulty in administering and enforcing structural protection requirements associated with this measure.
- If this measure was implemented, property transfer would probably still continue to occur.

(9) Health & Safety

- Degree of structural flood and erosion protection on new dwellings is generally limited per individual structure. Therefore, protection provided would not be complete.
- Compensation for damages would provide a sense of security to some degree to residents, as would required structural protection on new dwellings.
- Continued development in hazardous areas could subject increased population to hazard problems.
- Implementation of a flood/erosion insurance program would still not prevent flooding from disrupting community services and facilities to some degree. This could create temporary health and safety hazards (e.g., sanitary sewer overflows, flooded roads).

(10) Community Cohesion

- Protective measures associated with a flood/erosion insurance program and limited displacement of people may act as a local cohesive force.
- This measure may induce conflict as to protection needs, costs, responsibility, qualification, and future developments.
- Continued flooding and erosion hazards may disrupt community services and facilities, thus affecting normal community function and cohesion.

(11) Noise

- Since measure may provide for the purchase and removal of structures sustaining high and repeated damage in the flood plain, or, if future development is permitted in the flood plain, temporary noise during construction periods would unavoidably occur.

(12) Leisure, Cultural, and Recreational Opportunities

- If structural protection requirements are placed on new building developments under this insurance measure, it may tend to limit opportunity for new development expansion. Future trend in flood/erosion hazard areas may be toward recreation and leisure type developments instead of residential developments.

b. Cultural Criteria.

(1) Archaeological Sites

- If restrictions to future development are experienced by implementation of this measure, it could contribute toward conservation of archaeological resources by either slowing the rate of development or discouraging future development in the flood plain.

(2) Historical and Architecturally Significant Structures

- Should this measure be implemented, the removal of structures (some of which may be historic) from their original setting would affect the historic integrity of these structures.

(3) Submerged Cultural Resources

- No significant impacts on submerged cultural resources would be anticipated if the flood/erosion insurance measure was implemented.

c. Biological Criteria.

(1) Wetlands; (2) Fisheries; (3) Wildlife; (4) Threatened or Endangered Species; (5) Benthos; (6) Littoral Zone; (7) Vegetation; (8) Air Quality; (9) Water Quality; (10) Nekton and Plankton and, (11) Terrestrial Soils and Bottom Substrate

- The provision of flood/erosion insurance itself would probably not have a significant impact on the above-mentioned resource criteria, however, some impact on some of these criteria may occur if other aspects of the program are accepted and implemented. The first aspect dealing with purchase and removal of existing developed structures could unavoidably compact soils, disturb or destroy existing aquatic or terrestrial vegetation and nesting wildlife during operation of heavy equipment. Temporary dust and odor emissions from heavy equipment may have a short-term adverse effect on air quality, and, there could be some temporary sedimentation alongshore due to soil runoff from disturbed terrestrial areas.

(12) Topography

- Existing topography would be altered at sites from which existing structures were removed.

(13) Federal/State-Owned Natural Areas

- No significant impacts on existing Federal-State-owned natural areas are anticipated. Coordination with Federal and State natural resource agencies would be maintained to avoid conflict with existing or potential management plans.

d. Other Environmental Criteria.

(1) Erosion

- If actual movement of structures from problem areas occurs, soils disturbed by heavy equipment activity (e.g., removal of existing vegetation, excavation, etc.) may erode, unless such areas are promptly protected to reduce soil loss.

(2) Sedimentation

- Land disturbed during removal of structures along the shoreline may contribute sedimentation to the littoral zone during surface runoff periods, unless such lands are promptly protected to reduce soil loss.

(3) Water Levels and Flows

- No significant impact to water levels and flows would occur if this measure were implemented.

(4) Productivity

- If existing structures are moved from erosion and floodprone areas during the wildlife breeding season (e.g., May - July), heavy equipment activity and noise associated with moving could temporarily disturb and displace nesting species near such activity areas.

e. Economic Criteria

(1) National Economic Development

- The National Flood Insurance Program is available to all individual property owners in the communities covered by the program. Communities must comply with a flood plain management program which includes corrective and preventive measures for reducing flood damage, including emergency preparedness plans and any measures aimed at the future use of the flood plain. In order

for new structures to qualify for the insurance, coastal residential structures must have the lowest portion of the first floor elevated to or above the base flood level. Nonresidential structures have the option of making a structure water tight or elevating. These requirements have the effect of reducing flood damages in the participating communities. A reduction in flood damages contributes directly to the national output.

- Adverse impact of the program is that it tends to favor only intensive flood damages. A deductible provision in the insurance policy specifies the amount of loss the insurer must bear before he receives payments. This reduces the attractiveness of the National Flood Insurance Program for areas where flood damage is small but frequent.

(2) Local Government Finance

Taxes - The availability of flood/erosion insurance will not necessarily reduce development in the flood hazard zones. The restrictions on new structures could curb future residential and commercial development. An increase in tax collections will occur as new urban development rises. Removal and relocation of structures as a provision of the insurance program could change the tax collections.

Property Values - The National Flood Insurance Program is designed to provide for the purchase and removal of structures sustaining high and repeated damages. This would have an effect on overall value of land and structures if the residential dwellings are removed and placed in areas with higher property values.

Public Facilities - Public concerns can also receive insurance for the protection of public facilities such as sewage treatment plants. Future public facility construction is subject to local codes and ordinances which provide standards for the location and design of new development in floodprone areas.

Public Services - The reduction in emergency costs associated with flooding such as police and fire protection due to flood reduction measures is a benefit.

- Compliance with the flood insurance program can lead to a reduction in overall flood damages.

(3) Regional Economic Development

Real Income Distribution - The reduction in flood damages due to community participation in the flood plain management program will raise the regional income as it reduces the income losses sustained during flooding.

- The reduction in local emergency flood control costs will also be beneficial to regional income.

Employment/Labor Force - Flood plain management could reduce the number of emergency closure days due to flooding. The losses sustained by salaried employees is a direct loss to the regional income. The reduction in income losses due to fewer emergency days is a direct benefit to the regional economic development account.

Business/Industrial Activity - Benefits accrue to commercial interests in the flood insurance program to the extent that floodproofing measures are undertaken. Unfortunately, businesses will often only insure themselves when they expect severe flood damages to occur rather than frequent and small flooding damages. This happens because of the deductible provision in the insurance policy.

Agricultural Activity - No significant impacts are expected.

7.3.12 LAND MANAGEMENT

a. Social Criteria.

(1) Population Density

- Shoreline population density (particularly in hazard-prone areas) would develop only toward light to moderate levels.

- Population densities might well develop to higher levels generally in less hazardous areas or areas of particular character (outlets, bays, etc.). Developments in these areas, however, (generally subject to land management policies) would eventually be required to meet flood and erosion damage reduction standards, etc.

(2) Population Mobility

- Population mobility and opportunities might result through induced movement of people from hazard-prone areas or areas that might better be utilized to less hazrd-prone areas or areas suitably developed.

(3) Housing

- Housing opportunities might well increase in developing less hazard-prone areas or areas that meet hazard reduction standards and correspondingly decrease or remain unchanged in hazardous areas or areas utilized better as nonresidential under this measure.

(4) Displacement of People

- Direct displacement of people could, but would generally not, occur as a result of implementation of land management policies. Strong inducements for compliance to desirable policies and standards could result in long-term induced displacement particularly from existing developments.

(5) Transportation

- Land management programs and/or policies generally act to influence or regulate location, type, degree, and specifications of developments including transportation developments. Regulation of other developments may also influence the needs and demands for tranportation alternatives also.

(6) Desirable Community Growth

- Land management programs and/or policies generally reflect the desires of the community level or segment which enacts or develops the criteria of those policies. These policies do not always satisfy the desires of various levels or segments of the community. Desirable growth is also subject to change over time.

- Although some conflicts may arise, land management policies do contribute to desirable community growth by providing reasonable development plans and guidelines and usually contributing health and safety and damage reduction aspects.

(7) Aethetics Values

- Land management policies might be utilized to preserve aesthetic areas (sites), views and generally aesthetic integrity.

(8) Institutional Dynamics

- Implementation of viable land management policies requires significant coordination, cooperation, and understanding between and among the various levels and segments of community government and developmental interests. Agreeable criteria, standards and specifications must be developed, legislation must be enacted and enforcement and judicial procedures must be established. Review and revisisons over time would also be necessary.

- Land management policies might restrict but should contribute to wise and orderly development and interaction of community institutions.

(9) Health and Safety

- Credible land management policies would contribute significantly to community health and safety factors through coordinated planning efforts and safety factors through coordinated planning efforts to best utilize land areas, arrange community functional elements and institutions and eliminate significant hazard and damage-prone developments.

(10) Community Cohesion

- Coordinated planning efforts would contibute to common community

interest goals and thus to the community cohesion elements. (Community plan, land use, health and safety, etc.).

- Undoubtedly, conflicts could arise among various developmental regulation authorities and policies might be challenged.

- Pressure on existing developments to reform to developed standards, criteria, and land use might create conflict and disrupt existing community elements and community cohesion.

(11) Noise

- Land management policies may be utilized to regulate location and degree of noise-producing developments, and noise reduction measure enforcement may be enacted.

(12) Leisure, Cultural, and Recreational Opportunities

- Since land management policies generally promote low flood and erosion damage, land use developments along shorelines, and; numerous types of leisure, cultural, and recreation developments are low damage types, these developments might well be encouraged as a result of implementation of land management measures.

- Shoreline characteristics and emphasis of land use compatible with those characteristics (e.g. beach and beach activity, inlet and boating and fishing activity, shoreline and aesthetics, etc.) as a result of land management measures would further induce these types of developments.

b. Cultural Resources.

(1) Archaeological Sites

- Investigation of existing land characteristics for identification of land use designation may result in archaeological site findings.

- Generally induced low damage, low intensity developments would have less severe impacts to archaeological sites, than unregulated development.

- Significant archaeological sites may be identified as special zones and thus temporarily or permanently preserved.

- Shoreline flooding and erosion would continue disturbing some archaeological sites.

(2) Historical and Architecturally Significant Structures

- Investigation of existing land characteristics for identification of land use designation may result in identification of historical and/or architecturally significant structures.

- Generally induced low damage, low intensity developments may contribute to preservation of these structures.

- Significant structure sites may be identified as special zones and thus preserved.

(3) Submerged Cultural Resources

- Resulting developments as a result of land use designation (zoning) could have various impacts upon submerged cultural resources, (e.g. a recreational shoreline use designation may result in channel dredging, breakwaters, boating, etc.). See impacts for other alternative measures.

c. Biological Criteria.

(1) Wetlands; (2) Fisheries; (3) Wildlife; (4) Threatened or Endangered Species; (5) Benthos; (6) Littoral Zone; (7) Vegetation; (8) Air Quality; (9) Water Quality; (10) Nekton and Plankton.

- This measure is not anticipated to have any direct significant adverse effect on the aforementioned criteria but could prevent or regulate the future rate of human activity in or around wetland areas and associated fauna/flora.

(11) Terrestrial Soil and Bottom Substrate

- Terrestrial soils may be unavoidably disturbed on sites where development is permitted. No significant impact on submerged bottom substrates along the shoreline would be anticipated.

(12) Topography

- Existing topography may be altered at sites where development is permitted.

(13) Federal/State Fish and Wildlife Areas

- No significant impacts on existing Federal/State-owned natural areas are anticipated. Coordination with Federal and State natural resource agencies would be maintained to avoid conflict with existing or proposed management plans.

d. Other Environmental Criteria.

(1) Erosion; (2) Sedimentation

- Over the long run, utilization and implementation of building codes could contribute toward reduction of erosion since proposed new structures would have to meet established building requirements that may include construction standards requiring building development that would withstand wave and wind damage, or require setback location of new buildings to minimize shoreline damage to structures. Temporary erosion and sedimentation into the littoral zone could be increased by these new building requirements but these impacts are anticipated to be minor and should diminish soon after construction is completed.

(3) Water Levels and Flows

- No significant impact on water levels and flows would be anticipated if this measure was implemented.

(4) Productivity

- Biological productivity may increase along the shoreline if more open areas along the coastal zone are left undeveloped and existing natural areas are preserved by local ordinances. Depending on what land use intensity a given coastal area is zoned for, biological productivity may or may not be significantly impacted.

e. Economic Criteria.

(1) National Economic Development

- The purpose of these methods and rules is to reduce the damages to existing and future buildings due to flood and erosion damages. The extent to which these land use measures reduce flood and erosion damage is a measurement of the increase in national economic output.

(2) Local Government Finance

Taxes - The land use controls would result in a stabilization of the tax structure. The zoning ordinances, in particular, tend to maintain the existing value of land and structures. The total value of land and structures along the Lake Ontario shoreline are $26,861,000 and $78,258,900 respectively. There would be lesser changes expected in these values with land use controls in place to minimize the urban shoreline development.

Property Values - Conservation of property values is an important function of zoning laws and other land use measures. The maintenance of a residential district as such will assist in stabilizing the value of land and buildings. Invasions of commercial structures into residential areas would lower property values of existing residential structures.

Public Facilities - Coastal communities, because of market attractiveness of shoreline properties, have experienced substantial development pressures. The development pressures with or without land use measurements will increase the demand for public facilties. Zoning ordinances are beneficial in that they can assure adequate provision of transportation, water, sewerage, schools, parks and other public requirements.

Public Services - Land use management can promote the future development of areas that have availability of sanitary and storm sewers, water supply, and other utilities. A map showing existing service lines and logical extensions to them will assist the zoning commission in deciding where varous types of land uses can be encouraged in the future.

(3) Regional Economic Development

Real Income Distribution - Proper land use management can serve to strengthen the local economy by reducing the cost of government services for flood control and erosion protection. Losses to local developers and recreationists due to permit delays could be avoided. For example, if a recreationist must delay putting in a dock for a month, there is a loss of recreational value bsed on willingness to pay. Proper building codes can reduce the burden of disaster relief for local government. There is also an avoidance of income losses during flooding.

Employment/Labor Force - Employment percentages could increase with the growth in commercial retail and recreational establishments in the shoreline communities.

Business/Retail Activity - The shoreline communities can regulate the development of futue commercial activities through the use of zoning ordinances. The Port of Rochester, now zoned industiral, may be rezoned commercial to encourgae the development of the site as a recreational, service-oriented commercial district. Development of commercial activities can be geared to the benefit of local residents. Unwise developments cn be curbed through the use of land tools.

Agricultural Activity - The preservation of prime agricultural land is a goal of the Lake Ontario shoreline communities. Land use management, particularly agricultural district zoning, is used in Monroe and Wayne counties.

7.3.13 VEGETATION

a. Social Criteria.

(1) Population Density

- Reduction in slope degradation by rain and wind provided by this measure could contribute toward further expansion of existing and new beach type developments, which in turn, could increase population density along the shoreline.

(2) Population Mobility

- The greater degree of soil protection provided to shoreline bank slopes by this measure could contribute to further development, which in turn, could increase opportunity for attracting people into shoreline areas.

(3) Housing

- Induced development could provide opportunity for development of new housing or expansion of existing housing.

(4) Displacement of People

- Since protection provided by this measure would help maintain existing shoreline area, no significant displacement of people is anticipated.

(5) Transportation

- Reduction in bank slope erosion provided by this measure would help protect public and private roadways along the shoreline.

- Reduction in erosion from rain and wind may induce new or expanded roadway development.

(6) Desirable Community Growth

- This measure may contribute toward inducing further development along the shoreline, which could also create a need for additional community services and facilities.

- Regulatory measures which may be required to protect vegetation from excessive traffic may limit types of activities and developments in the vegetated area.

(7) Aesthetic Values

- Implementation of this measure would alter the natural setting.

- Exposed bank slopes subject to rain and wind degradation would be provided an improved degree of protection. This would help conserve some existing shoreline vegetation and help maintain the natural setting.

- Vegetation planting may help improve the visual quality of the shoreline.

(8) Institutional Dynamics

- No significant impact is anticipated on institutional dynamics by this measure.

- *Institutional traffic control* regulation may be required to protect vegetation from trampling which could alter its protective characteristics.

(9) Health and Safety

- This measure may increase a sense of safety in residents from shoreline damage to personal property - land, structure, and contents.

(10) Community Cohesion

- Provided protection by this measure could induce conflict relative to protection needs, cost, and future development interests.

- Provided protection by this measure could indirectly contribute toward strengthening community cohesion among residents.

(11) Noise

- Use of construction equipment to prepare bank slopes for seeding, and use of mechanical planting equipment would temporarily cause some noise.

(12) Leisure, Cultural, and Recreational Opportunities

- Increased degree of protection provided to shoreline bank slopes may be inducive to further beach development and associated activities.

- Graded and planted bank slopes may provide increased incentive for shoreline recreational fishing *in areas where formerly* access was not possible or restricted.

b. Cultural Resources.

(1) Archaeological Sites

- Disturbance of soils by grading and seedbed preparation could destroy or alter archaeological resources.

- Herbaceous or woody plantings with potential for growth of large, deep-root structures could disturb the internal integrity of archaeological sites by causing displacement of artifactual material.

- *Introduction of plant roots into undisturbed carbon deposits* could induce significant error into materials conducive to radio carbon dating.

(2) Historic and Architecturally Significant Structures

- No significant impact on historic structures is anticipated.

(3) Submerged Cultural Resources

- Since this measure pertains primarily to terrestrial shoreline areas, no significant impact on submerged cultural resources is anticipated.

c. Biological Criteria.

(1) Wetlands

- During seedbed preparation and seeding/planting periods - until plants become established - exposed bank slopes would temporarily have little or no vegetation cover. Some soil erosion due to wind and rain could occur during these periods, which may wash sediment downslope into the lake. In turn, wave action or current flow could transport suspended sediments into shoreline wetlands.

- Once planted, vegetation cover establishes on bank slopes, herbaceous and/or woody plants would help slow up surface runoff by acting as a sediment trap.

(2) Fisheries

- During periods of little or no vegetation cover, sediment runoff from terrestrial bank slopes would probably contribute to temporary turbidity in shallow in-shore waters. Some suspended sediments may eventually disperse and settle out onto existing aquatic habitats used by fish as spawning, feeding, and nursery areas.

- Once vegetation cover establishes on planted bank slopes, sediment runoff into shoreline fish habitats would probably be reduced from formerly eroded bank sites.

(3) Wildlife

- During seedbed preparation and seeding/planting periods - until plants become established - exposed terrestrial bank slopes would provide little to no food and cover habitat for wildlife.

- Use of heavy equipment to prepare and seed sites may destroy or temporarily disturb some game or nongame mammal, bird, reptile, or amphibian species utilizing the project site.

(4) Threatened or Endangered Species

- Whether or not possible loss of significant habitat and disturbance to any rare or endangered fauna and flora would occur,

would be investigated through coordination with Federal and State fish and wildlife agencies during subsequent planning stages.

(5) Benthos

- As indicated under probable wetland impacts, some soil erosion due to wind and rain could occur during seedbed preparation and seeding/planting periods which may wash downslope into the lake. Eventually, suspended sediments would disperse, settle out, and be deposited onto existing shoreline lake bottom, thereby contributing toward alteration of existing benthic habitat. Destruction and/or disturbance of some associated benthic invertebrate organisms from sediment deposition may occur.

(6) Littoral Zone

- Soil particles lost through surface runoff over sites being prepared for vegetation planting may be deposited into littoral waters alongshore. Suspended soil particles could temporarily reduce sunlight penetration in shallow water until terrestrial plantings become established.

- Vegetation plantings on eroded shoreline sites would directly help reduce soil loss normally available for littoral zone transport. However, this measure may contribute toward reducing total amount of sediment available for transport by littoral currents to nourish downstream beach areas.

(7) Vegetation

- During site preparation for planting, some existing natural vegetation would probably be unavoidably destroyed by heavy equipment.

- Sites formerly subject to more frequent erosion would be planted with herbaceous and/or woody vegetation. Once vegetation plantings were established, there would probably be more dependable and stable cover on formerly unprotected erodible sites.

- Some overhanging shoreline vegetation, such as trees clinging to unstable soils on bank sites experiencing erosion, may have to be removed, prior to replacement with herbaceous vegetation.

(8) Air Quality

- There would be some temporary, unavoidable adverse impact on air quality due to increase in dust and odor during use of equipment to grade bank slopes and plant vegetation.

(9) Water Quality

- Prior to establishment of planted vegetation, erosion from surface runoff and wind over exposed soils could contribute toward a temporary increase in inshore water turbidity.

- Anticipated reduction in soil loss to inshore waters, provided by more stabilized bank slopes attributable to a buffer of planted vegetation, would help reduce adverse impact on water quality by trapping soil particles and some agricultural runoff.

(10) Nekton and Plankton

- Since this measure would apply principally to planting of terrestrial vegetation on bank areas above water that are experiencing erosion, no significant direct impact on free-swimming aquatic animals (Note: indirect impacts are mentioned under the category "fisheries" in this section) or on minute plant and animal organisms associated with the inshore zone.

(11) Terrestrial Soils and Bottom Substrate

- Established vegetation plantings would help conserve soil and decrease the rate of erosion by trapping sediment on bank soils normally exposed to significant wind and rain impact.

- Some soil loss is anticipated due to surface runoff over exposed soils prior to planting.

- Since inshore bottom substrate along the lake generally experiences scouring and shifting by wave action, sediment deposition from surface runoff received from planting sites would probably not accumulate to a significant degree.

- Planted vegetation on eroded terrestrial sites would help absorb energy of falling rain, thereby protecting these soils to some degree.

- Planted vegetation would help maintain absorptive capacity of the soil; such vegetation also helps remove water from bluff areas through uptake and transpiration.

(12) Topography

- Some change in existing terrestrial relief would occur due to grading of eroded bank sites in preparation for planting of vegetation. The natural topographic land feature on such sites would change from an irregular eroded sparsely vegetated or barren area, to a more evenly vegetated, smoother man-made relief appearance.

(13) Federal/State Fish and Wildlife Areas

- Coordination with fish and wildlife agencies would be maintained to avoid conflict with existing or proposed habitat management plans.

d. Other Environmental Criteria

(1) Erosion

- Long-term reduction in rate of terrestrial soil loss is expected due to increased erosion protection provided by planted vegetation cover.

- Vegetation planting alone cannot control deep-seated movement of shoreline bluffs due to groundwater seepage.

- Generally, terrestrial slope vegetation would not provide much protection from lake water wave action, but would have to be used in combination with some type of structural measure to be more effective.

(2) Sedimentation

- Some increased sediment from disturbed terrestrial bank soils would probably wash or blow into the shallow inshore aquatic zone, due to surface runoff or wind action over the planting site while the site was barren of vegetation cover. Such sedimentation would decrease as improved as vegetation became well established and root systems provide a soil binding effect.

(3) Water Levels and Flows

- No significant impact on water levels and flows is expected to occur if this measure is implemented.

(4) Productivity

- Vegetation plantings, once established, may provide improved cover habitat for some small species of terrestrial wildlife on bank erosion sites formerly having poor to no vegetation. Vegetation cover provided may indirectly potentially benefit game and nongame wildlife productivity and productivity success, by providing more long-term habitat attractive to some species for nesting and rearing of broods.

e. Economic Criteria.

(1) National Economic Development

- The use of vegetation should be in conjunction with structural devices. This measurement reaches its height of effectiveness

during low water levels. Vegetation loses its density during high water levels.

- The benefits to the national output accrue due to the reduction in flood damages and erosion protection. The depreciation of commercial and residential structures would decrease due to reduced erosion rates and increased shoreline stability.

- Benefits also accrue to agricultural production. The costs of damages to crops due to erosion and flooding is reduced. Vegetation would reduce the need for high maintenance and replacement costs for irrigation, drainage, or flood protection systems. The provision of vegetation protection would allow the planting of a larger variety of crops as well as those that are tolerant of flood, erosion, or wet soil conditions.

(2) Local Government Finance

Taxes - The response of the tax base to the placement of vegetation will depend on the development induced. An increase in tax collection will occur as the shoreline is claimed for more intensive land use purposes.

Property Values - Both the value of land and structures will grow as the shoreline is urbanized. Vegetation will protect property against erosion and flooding and result in higher property values.

Public Facilities - The vegetation could provide protection to water resource facilities in the protected areas. Electricity, gas, power, water and sewage, and transportation facilities are inclusive. The protection of roads and public transportation facilities along the shoreline would encourage further development since they are important features for an area's development.

Public Services - Induced commercial and residential development will result in larger demands in public services.

(3) Regional Economic Development

Real Income Distribution - The expansion of commercial activities in protected areas will expand the income sources for the local community. The new and expanded businesses provide wages to the local populace.

Employment/Labor Force - Expansion of local commercial activities would result in reducing local unemployment or attract new people to the community. Skilled labor is more likely to be drawn from outside the local labor pool. The increase in local employment will result in subsequent increases in local personal per capita incomes.

Business/Industrial Activity - Vegetation protection will encourage business activities to expand due to flood and erosion protection. The reduction in physical damages to structures will lower risks of operation in

floodprone and erosion hazard areas. Future losses will also be reduced as inventories receive additional protection.

Agricultural Activity - Displacements of farms could occur if commercial and residential land use increases.

SECTION 8
STUDY MANAGEMENT

LAKE ONTARIO SHORELINE PROTECTION STUDY

SECTION 8

STUDY MANAGEMENT

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SECTION 8 - STUDY MANAGEMENT

The Secretary of the Army, acting through the Chief of Engineers, U.S. Army Corps of Engineers, was directed by the Congress of the United States to conduct the Lake Ontario Shoreline Protection Study. The study was assigned by the Office of the Chief of Engineers to the Division Engineer, North Central. In turn, it was assigned to the District Engineer, Buffalo District, within whose District the study area lies. As the accountable official for its conduct, the District Engineer assumes full responsibility and control for the accomplishment of all aspects of the study including its conclusions and recommendations.

8.1 INTERDISCIPLINARY STUDY APPROACH

Requirements of P&S, NEPA, and Section 122 of the River and Harbor Act of 1970, among others, demonstrate the need for an interdisciplinary planning approach to managing and developing our Nation's natural resources. Such an interdisciplinary approach has been used during Stage 1 and will continue to be used during subsequent stages of the Lake Ontario Shoreline Protection Study.

An interdisciplinary study approach is best accomplished by a planning team which employs a diversity of professional skills. This approach does not mean that all participants must be involved in each activity, task, or stage, only that they are involved when their skills could have a material effect on study progress and output. During Stage 1, a planning team from Buffalo District staff was utilized. It included a study manager, a terrestrial ecologist, an aquatic biologist, a sociologist, an archeologist, an economist, a coastal geologist, and a hydraulic engineer. The efforts of Corps personnel were augmented with the services of Contractors, and the input by U.S. Fish and Wildlife Service and New York State Department of Environmental Conservation.

The study has been coordinated with various international, Federal, State, regional, and local agencies and organizations, and the general public. Information, data, and views of various agencies with varied expertise have been also solicited. Two committees have been established to provide input to the study. The first is the Interagency Coordination Committee representing various Federal, State, regional, and local agencies. The second is the Citizens Advisory Committee representing the riparian and recreational interest of the study area. These committees were established during the latter part of Stage 1, and therefore have had no input to Stage 1. There first contribution will be through their review of and comment on this report.

The services of an Architect/Engineer (A/E) firm will be contracted to conduct the remainder of the study with the exception of fish and wildlife studies. These latter studies will be conducted by the U.S. Fish and Wildlife Service under an Interagency Agreement. The A/E firm, Normandeau Associates, Inc. of Bedford, NH, was selected using Department of Defense procurement procedures. The firm was judged to be the best overall of the 26 prospective firms which responded to a Commerce and Business Daily

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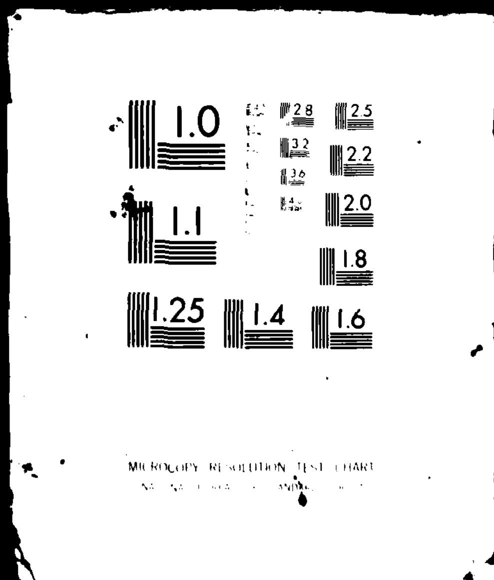

advertisement. The selection criteria emphasized interdisciplinary expertise and experience. The Contractor will be required to continue the interdisciplinary approach of the study.

8.2 PUBLIC INVOLVEMENT

It is the policy of the Corps of Engineers that civil works projects, under authority of the Corps of Engineers, be conducted in an atmosphere of public understanding, trust, and mutual cooperation. This is accomplished through actively involving the public in water resources studies by opening and maintaining channels of communication.

To provide the needed expertise for implementing an effective public involvement program for the study, the service of a public involvement Contractor was procured. Through the Corps procurement process, Great Lakes Tomorrow was selected. With the emphasis on identification and definition, rather than resolution, public involvement was directed towards insuring the articulation of a wide variety of viewpoints and concerns so that they could be considered in the planning process. The contract was accomplished in two phases.

The first phase emphasized identifying public concerns and problems associated with Lake Ontario, its shoreline, and the study. Previous public involvement efforts were identified and reviewed. Publics were identified for purposes of establishing a mailing list. An information brochure was developed describing the study, the role of the public, the study process, issues such as lake level regulation and public concerns from previous public involvement efforts. Facilitative workshops were held at five locations along the shoreline during 6-9 August 1979. Four were oriented to the general public and held during the evening. The fifth was held during the day for accessibility by agencies and elected officials. Following the workshops a "feedback" brochure was developed and mailed to the workshop participants summarizing the results of the workshops. Issues and concerns identified at the workshop are provided in Appendix B and summarized in Section 4.3.

Phase 2 was oriented to assessing impacts of possible measures to be investigated during Stage 2. Two information brochures were developed prior to the five workshops which were held during the week of 23-27 June 1980. As during the first phase a "feedback" brochure is being developed. Results of this second series of workshops will be provided in the Stage 2 report.

Recommendations from the public on how the public involvement program should be structured were sought by questions on the workshop registration forms, and in those workshop sessions where time permitted. The public provided input on such things as which publics should be involved in the study, appropriate methods of public notification and involvement, as well as who would conduct future programs. Information requirements for review of alternatives and means of response were included.

Based upon this input and the recommendations of Great Lakes Tommorrow, the following is a discussion of the public involvement program for the remainder of the study.

First of all, it should be reiterated that the Buffalo District intends to actively involve the public throughout the Lake Ontario Shoreline Protection Study, and is committed to providing a public involvement program which serves both the purposes of the study team and the public. A program that essentially makes the public a part of that team, but still recognizes their different needs.

Future public involvement efforts will be a continuation of the program utilized during Stage 1 and will provide a progressive educational effort.

The individuals and groups who identified themselves as interested publics through attendance at workshops or through mailed returns form an obvious base of participation, numbering about 300. Third party identification through questionnaires and workshop responses produced both useful categories and many specific agencies and organizations. In the past, local officials and environmental groups have had limited representation at workshops. Therefore, specific and more active attention will be given to these groups. Identification of publics will focus on including those who may gain or lose economically, those affected by alternative plans, and publics whose patterns of activity or perception of values would be changed in some way. These publics will be incorporated in future mailings to locate specific representation.

The information/education aspects of the public involvement program must be structured in full recognition of the complexity of shoreline processes, the varied nature of the land/water interface, and the limited information available to the public. The publics which have been identified will be approached with newsletters or "fact sheets" which will identify opportunities for involvement. The newsletters will serve as the centerpiece of the program and they will focus interest, provide continuity, establish linkages among publics, as well as furnishing a vehicle for reporting study developments, calendared events, and progress reports. These newsletters will utilize a multipage format and be written in laymen's terms. Opportunities for return comment will also be provided. The news media will also be utilized to augment this information/education process. Press releases will be furnished on coming events and news articles will be provided on pertinent subjects. The Interagency Coordination Committee will be utilized as a forum for providing briefings to related agencies to provide for their meaningful input.

The Citizens Advisory Committee will be utilized as a "sounding board" for riparian and recreational views and concerns. Briefings and detailed information will be provided to the committee to assist them in providing more knowledgable input to the study than could be gotten from the general public.

Study reports, such as this Reconnaissance Report, and the Preliminary Feasibility Report and the Final Report at the ends of Stages 2 and 3 respectively, will be made available to the public through limited distribution. Draft reports will be provided to select agencies and the two study committees for their review and coordination. It will also be placed

in community and university libraries and Federal depositories to enable access and review by the general public. Following a formal review period, a public hearing will be held, whereby public evaluation of the reports will be possible. Incorporation and/or address of comments and criticisms will be incorporated into the final Reconnaissance Report. This report will be placed in libraries for reference by the publics throughout the study. The publics will be notified as to the locations.

Facilitative workshops will continue to be used as the primary means of soliciting public input to the study, although they will be augmented by interviews with agencies and publics, and by way of correspondence.

In determining who should conduct the public involvement program, several considerations were taken into account. These were:

a. Expertise in conducting public involvement programs.

b. Capacity for conducting continuing public education.

c. Objectivity and established credibility.

d. Skills in communicating and interpreting technical issues/information.

e. Access to local, regional, and basin-wide publics; knowledge of regional issues.

f. Capacity for concurrent analysis of study products.

g. Knowledge of associated technical, institutional, and system factors.

h. Capability for policy analysis.

i. Potential access to Canadian publics.

Realizing that no one entity could readily meet these considerations, a division of functions among Corps in-house staff and appropriate outside sources was necessary. The use of an appropriate outside source, such a Sea Grant, or the Coastal Zone Management Program, would be appropriate in providing technical information/education programs to local groups. Shared program responsibilities may also be possible. The use of a neutral third party to conduct prehearing briefing sessions will be used. Facilitative workshops will also be conducted by a third party, preferably one who is trained in the necessary public involvement techniques such as a Contractor, agency, or organization. A technically qualified source will be utilized in developing and preparing information for newsletters and the media in order that the information is provided in a clear and concise manner, and presents all the relevant issues. If Canadian coordination becomes more actively pursued than is presently allowed, the use of an appropriate agency or organization will be necessary. Corps personnel will be used to manage the program so that it is timely and coordinated with the overall study. Staff will be utilized as a resource base to all aspects of the program.

During Stage 2, the Contractor, Normandeau Associates, Inc., who will be conducting Stage 2 study efforts, will also be responsible for the public involvement program. This will include information materials and workshops. Educational programs with other agencies will be pursued by the Corps staff.

8.3 ENVIRONMENTAL IMPACT STATEMENT

An Environmental Impact Statement (EIS), as required by Section 102(2)(c) of the National Environmental Protection Act, will be prepared in conjunction with the study report. The EIS will be an integral part of the interdisciplinary plan formulation process and will serve as a summation and evaluation of the effects, both beneficial and adverse, that each alternative action would have on the environment. It will also serve as an explanation and objective evaluation of the finally recommended plan.

The environmental statement will fully discuss the primary and secondary environmental effects including the social and economic impacts of the various alternative plans. The interdisciplinary environmental investigations carried on throughout the study and leading to the preparation of impact assessment and EIS will be undertaken simultaneously with, and to the same depth and scope as study related engineering, economic, and technical studies. The EIS is considered as an integral part of the study planning process and as such, is one of the documents upon which a decision on a Federal action is based. It will be written so as to substantively stand on its own and will be submitted, as an integral part of the Final Report, for review by the public and other governmental agencies.

The first document prepared during the development of the EIS is the Summary of Environmental Considerations (SEC) and will be a part of the Preliminary Feasibility Report (PFR) at the end of Stage 2 - Development of Intermediate Plans. The SEC is a summary, based on information developed in the study related environmental inventory or baseline studies. The SEC will be attached to the announcement for the public meeting at the end of Stage 2 in order to facilitate meaningful and thorough discussion during the meeting. The SEC will be updated throughout Stage 3 - Development of Detailed Plans and again presented for discussion at any public meetings held during this stage.

At the end of Stage 3, a Draft Environmental Impact Statement (DEIS) will be prepared and circulated for review and comment as a part of the Draft Final Feasibility Report (DFFR). It will present and discuss the anticipated environmental effects of the plan which may be recommended by the District Engineer along with the probable environmental impacts of the alternative plans considered in the study.

Once comments have been received and addressed, and any revisions to plans or plan selection are made, the Final Feasibility Report (FFR) and Revised Draft Environmental Impact Statement (DEIS) are prepared addressing the final study recommendation. These will then be sent to higher authority to serve as the decision documents for ultimate recommendations to Congress. Following review and comment and just prior to forwarding to Congress, the final EIS is prepared addressing the recent comments.

8.4 TECHNICAL STUDIES REQUIRED

Stage 2 of the Lake Ontario Shoreline Protection Study will focus on the development of a broad range of alternative plans to meet the planning objectives. The purpose of Stage 2 is to screen these plans by carrying out sufficient iterations of the four planning tasks (see Section 1) to decide which plans, if any, warrant more detailed study in Stage 3. In addition to the formulation of plans, and to a lesser degree, the other planning tasks, technical studies are conducted to support the activities which are done during the planning tasks and to assist in directing more detailed studies during Stage 2. These technical studies are as follows:

8.4.1 ENVIRONMENTAL STUDIES

Pilot Baseline Studies - Two pilot wetland areas have been selected for detailed investigation during Stage 2. The purpose of these studies is to gather baseline data of two selected wetlands, Campbell Marsh (Jefferson County), and Sage Creek Marsh (Oswego County), and using this data, to develop a model which will correlate key wetland descriptors and lake levels. Methodologies and studies will be developed to facilitate future systemwide investigations and evaluations during Stage 3. These Stage 2 studies are divided into two phases. The first phase which was started in August 1980 will include 1-foot contour mapping of the wetlands and offshore areas, vegetation mapping, vegetation survey, data analysis, and a report, and scoping of Phase 2 studies. Phase 2 will focus on investigating benthic invertebrats, fish, reptiles, avifauna, mammals. The selection of sites and development of the scope of work for these studies was done by USF&WS in consultation with NYSDEC and the Buffalo District. Field studies are being done by USF&WS with assistance from Corps personnel and in consultation with NYSDEC.

Cultural Resources Predictive Model Survey - In accordance with the National Historic Preservation Act of 1966, NEPA, Executive Order 15593, Procedures for the Protection of Historic and Cultural Properties (36 CFR, Part 800), and Identification and Administration of Cultural Resources (33 CFR, Part 305), a study of the cultural resources of the Lake Ontario and St. Lawrence River shoreline has been initiated. This study is being conducted jointly with the St. Lawrence Seaway - Additional Locks Study. The study will inventory known architecturally significant, historical sites, and known submerged cultural resources sites. A model will be developed to predict archaeological sensitivity of the area.

8.4.2 ECONOMIC STUDIES

Economic Correlations - To perform an economic analysis of shoreline protection for a specific area, benefits are derived from damage prevented. During Stage 1 such an analysis was performed using some simplifying assumptions. The assumptions generally gave a liberal representation of the damages. For Stages 2 and 3, the analysis must become more exacting. Thus, a better correlation of damages is necessary. An analysis of market values of property along Lake Ontario will be performed with a view to providing a relationship between setback and property value. This will provide a depreciation function for use in determining the depreciation of property value

over time due to erosion. A functional relationship will also be developed to correlate structural damage on homes due to wave attack. Such a relationship will correlate wave height, first floor elevation, setback, and structure value.

8.4.3 ENGINEERING STUDIES

Critique Existing Regulation - This item of work will be accomplished by the Stage 2 Contractor. It will consist of reviewing past regulation of Lake Ontario with a view to determining where changes thereto could be made and whether past regulation should have been different. This latter item will be based upon information which was available to the Board at the time and not on hindsight.

Hydrologic Analyses - Considering both deterministic and stochastic techniques for assessing hydrologic variability, existing and alternative regulation plans will be developed and evaluated on the basis of recorded historical sequence of supplies, levels and flows and on the basis of statistically compatible simulated sequences of supplies, levels and flows. The two methods will be compared as to their results, application, and costs, and reliability.

Mathematical Representation of Levels and Flows - A method for representing the interrelationship of the levels and flows of the Great Lakes, and their relationships to causative factors will be developed. These factors will include natural factors such as meteorology, hydrology, and hydraulic characteristics of the Great Lakes watershed, as well as artificial factors such as existing or proposed constraints on the regulation of levels and flows. The representation (mathematical or computer model) shall be capable of determining, based on input constraints, the regulation plan which would optimize the combined effects on all affected interests. The model will be capable, also, of assessing the benefit/disbenefit of regulation plans on the affected interests.

Sediment Budget Analysis - This will consist of a literative search and sampling as necessary to determine the rate, type, source, and direction of sediments along the shoreline.

Engineering Designs - This will consist of site specific designs of both structural and nonstructural plans. Designs will conform to the site conditions at a given location.

8.4.4 OTHER STUDIES

Institutional Study - This study, initiated in June 1980, documented an analysis of the institutional infrastructure of the Lake Ontario shoreline. It included the identification of institutions, both agencies and authorities, pertaining to planning, assistance, and regulation functions with primary focus on the implementation of nonstructural measures. Also included was an analysis of judicial interpretation of existing authorities. Recommendation will result for subsequent study development to improve the analysis and presentation of institutional arrangements. The study was completed in March 1981.

8.5 POLICY ISSUES TO RESOLVE

Under existing beach erosion control laws Congress has authorized Federal participation in the cost of restoring and protecting the shores of property on the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and lakes, estuaries, and bays, directly connected therewith. Federal participation is based on the shore ownership, use, and type and incidence of benefits. If there is no public use or benefit, Federal funds can not be used. Thus, for privately-owned property, there is no cost sharing, unless there is a public benefit.

This is in contrary to the Federal interest in cost sharing of flood control projects. On the Great Lakes, the Federal interest in protection from flooding is not explicitly defined by legislation, but has been defined by precedent authorizations at 70 percent of the first cost of the protection. In June 1978 the President proposed that cost sharing for this type of protection be modified to require a cash or in-kind contribution by the non-Federal interest equal to 20 percent of the project investment costs. There are no restrictions regarding shoreline ownership or public benefit for lake flooding. Thus, for Lake Ontario, there is a Federal interest in and cost sharing available for protecting the shoreline from damages due to wave caused inundation, but not for damages resulting from erosion which may in fact be caused by the same waves.

The study authorization directs that the study report to Congress shall contain proposals for equitable cost-sharing. This has been interpreted to mean that the study is to evaluate the present Federal interest in shoreline eorsion and flood protection and determine whether present Federal policy thereof is equitable. Because of the National ramifications of this policy issue, its resoution must be accomplished at the Washington, DC level. It is proposed that the determination of who will conduct this aspect of the study and its methodology will be accomplished during Stage 2 and any required studies, such as incidence of benefits, and determination of policy be accomplished during Stage 3.

SECTION 9

CONCLUSIONS AND RECOMMENDATIONS

LAKE ONTARIO SHORELINE PROTECTION STUDY

SECTION 9

CONCLUSIONS AND RECOMMENDATIONS

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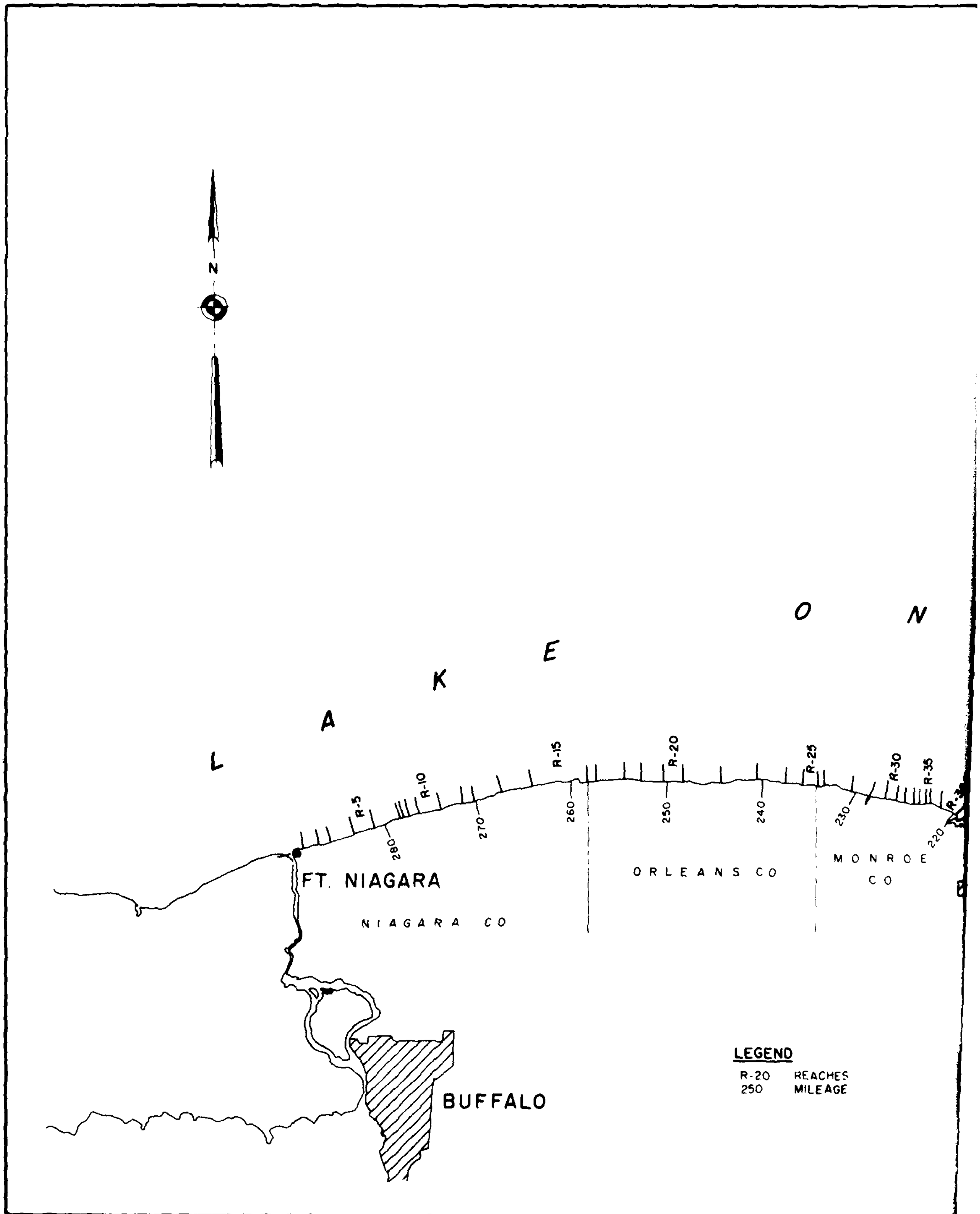
SECTION 9 - CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS

As a result of the analysis of the problems, needs, and opportunities of the Lake Ontario shoreline within the United States, it has been determined that the damages resulting from erosion and lake flooding are severe and widespread. It has also been determined that there are methods for alleviating such damages, and there appears to be economic feasibility of some of those methods. In view of these determinations, other related problems and needs, and the support for the study by the State of New York, other agencies and the riparian land owner, it is concluded that further study is warranted.

9.2 RECOMMENDATIONS

It is recommended that this Reconnaissance Report be approved and Stage 2 of study development proceed.



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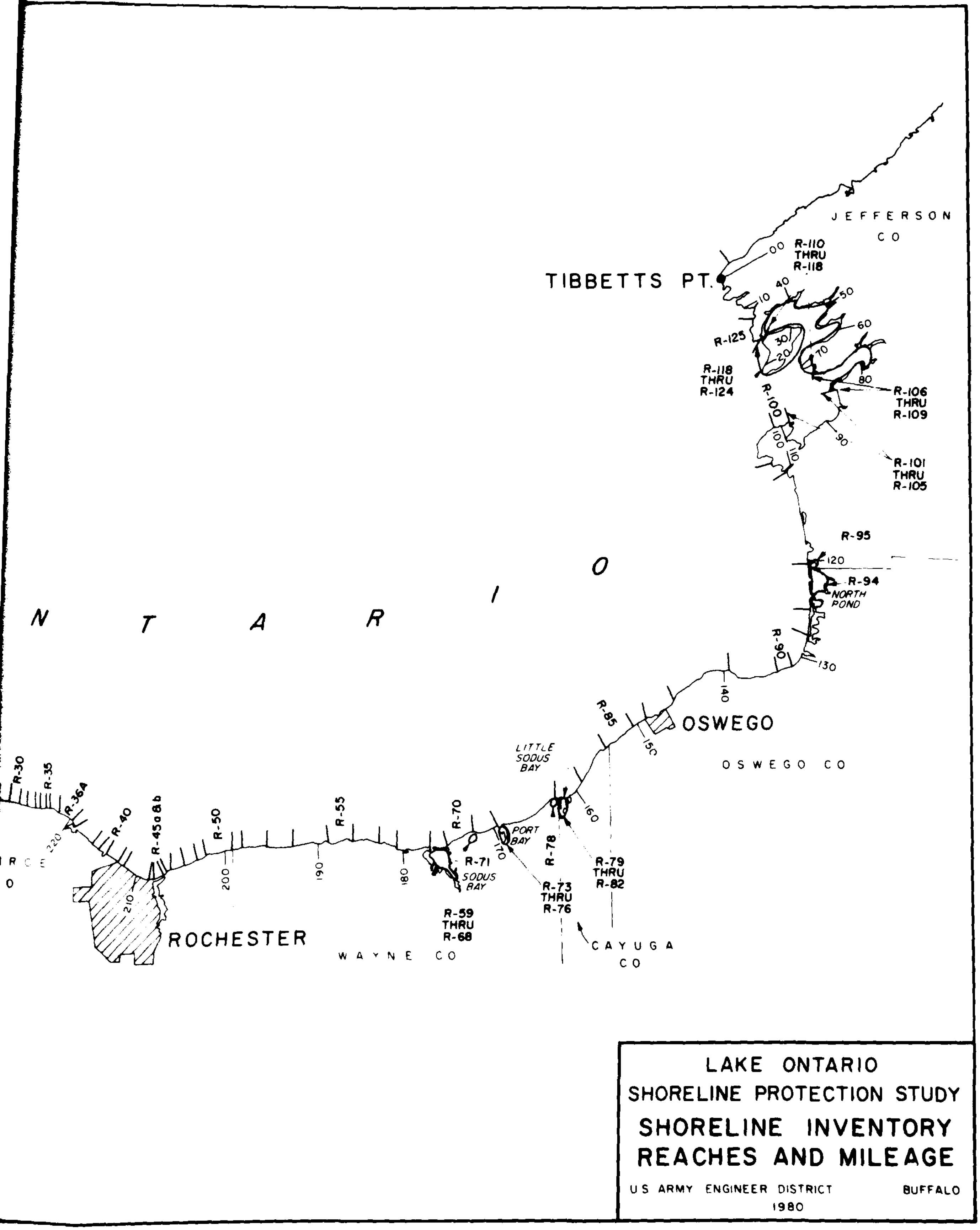

LAKE ONTARIO
SHORELINE PROTECTION STUDY

SHORELINE INVENTORY REACHES AND MILEAGE

US ARMY ENGINEER DISTRICT BUFFALO
1980

Plate 1

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APPENDIX B

ISSUES AND CONCERNS

LAKE ONTARIO SHORELINE PROTECTION STUDY

APPENDIX B

ISSUES AND CONCERNS

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APPENDIX B

ISSUES AND CONCERNS

Important characteristics of Stage 1 of the study process are that it is exploratory in nature and it aims at being comprehensive with regard to identification of problems and needs of the study area. The primary components of problem identification are the definition of existing conditions, the projection of future conditions, and the identification of public concerns.

In August 1979, a series of five facilitated workshops were conducted along the shoreline of Lake Ontario. These were held at Watertown, Mexico, Rochester, Irondequoit, and Wilson, NY. All, but the Rochester workshop, were held in the evening for the convenience of the general public. The Rochester workshop was held during the day and oriented toward agencies and elected officials.

The workshops were conducted under contract with Great Lakes Tomorrow, a nonprofit and international citizens' organization. The following are the issues, concerns, and problems which were identified at the workshops:

1. PLANNING

1.1 GENERAL

• If erosion cannot be banished, can you pick those areas you wish to protect and allow other areas to erode naturally? Otherwise, the beaches will become starved and erosion will be greater than it is at present.

• How can the effectiveness of a proposed solution be determined so the risk of tradeoffs are understood at the decision point?

- Can you make sure solutions don't bring about additional unwise development that could make future problems even worse?

- Will impact analysis consider what should be done to preserve the shoreline if traffic use is increased (as a result of protection, use)?

- Will impact analysis identify whether any other COE project will affect the shoreline in a primary or secondary way?

- Will impacts of alternatives and protection measures, both primary and secondary, be addressed?

• Will COE consider the question of esthetics when evaluating alternative measures?

• How much use does the COE make of international information regarding solutions for shoreline erosion problems used in other nations such as

Holland, Denmark, etc.? Do we have to reinvent the wheel? How can we be sure we have adequate data and use what exists?

- Why doesn't COE pay more attention to erosion along the shore than some of the other issues they address, such as marina launchings and other temporary structures?

- How can a management system of controls to solve shoreline problems look at the big questions - those dealing with other than purely local interest? For example, can we examine the Monroe County development plan, looking at existing zoning, planning, community need, and public access to the shore?

- Can we acknowledge that the water is powerful, that there may be acceptable solutions to shoreline problems, but those proposed should make sense in reality as well as on paper? Can solutions be both esthetically pleasing and functional? Can we take time to educe and communicate to the public that there are natural processes and that land management must take cognizance of these? What will be the effect of the solution on the rest of the environment?

- Will COE staff physically visit this area to see the situation at first hand?

- What can be done about decentralized planning and poor control of development along shoreline?

1.2 <u>COORDINATION</u>

- Will both causes and solutions be viewed from a system-wide perspective?

  - Will the study consider the entire Great Lakes system and recognize the different characteristics of each lake (re-erosion)? Can a survey be made of all the major erosion areas on all the Great Lakes and result in suggestions for the best type of protection?

  - Will study be approached from at least the Lake Ontario-St. Lawrence River system in assessing consequences of any specific proposals?

  - Will the interrelationships or effects on the system upstream on Lake Erie or downstream on the St. Lawrence, of any activity on Lake Ontario, be considered?

  - How will multiple objectives be satisfied, such as navigation, power, economic, riparian, levels, environmental quality, wetlands preservation, and recreational access within a dynamic system?

- Is it legitimate to consider all lakes together since conditions differ on each lake?

- Will you identify the impact of winter navigation?

• How can coordination with Canada during this study be achieved? Will the permission of the Canadian government be necessary to accomplish shoreline protection? If so, how can we develop stronger ties in dealing with erosion issues?

- Can there be an early definition and determination of whether the program can have influence or impact on the IJC? If not, is the study worth continuing, because of the lake level control alternatives?

- Will IJC-Canada be included in the study program? What are the relationships and/or agreements between the IJC and the COE?

- Can the COE work with the IJC to see if demonstration programs can be conducted to determine the effects of lower Ontario lake levels?

- What has happened to the IJC Advisory Committee on lake levels?

- Shouldn't riparians be represented on the IJC and on Lake Levels Boards?

- Shouldn't riparian owners be represented on the St. Lawrence River Board of Control? There is a conflict of interest in decisions made by the Board when navigation and power interests are represented but riparian owners are not.

- How can the apathy of riparian owners who did not come to these workshops be addressed?

• How will this study and other related studies be coodinated? (Examples: Winter Navigation, Lake Frie Levels Regulation, Coastal Zone Management, Irondequoit Bay)

- How can winter navigation even be considered when levels may have to be raised an additional foot, thus adding to the problem? How will extension of the shipping season affect shoreline owners?

- How will the COE study and the New York State CZM program be coordinated? For example: DEC will be preparing maps showing critical erosion along the shoreline, which the COE could use to avoid duplication, meanwhile sharing their own data with DEC. How will other CZM erosion studies and information be used? Are the two problems related, and if so, why do we need this study?

- How can the New York State Department of Public Service Study of the lake's aquatic resources and this study become a cooperative venture and avoid duplication?

- How will New York State Recreational Access Study be coordinated with this study?

- Why has DEC issued a permit to mine sand near Sandy Pond and Mennan's Head?

- Will the responsibility of various government agencies for decisions on development in hazard areas, lake level controls, etc. be reexamined?

- Can we identify responsibility of local town boards or counties relative to shoreline erosion and this study?

• How can cooperation and coordination among agencies (and individuals) addressing the same issues be achieved? Can responsible agencies be identified, and those with power to implement, in order to achieve effective coordination? Can riparians be included to insure that a cure for one is not the cause of another's problem?

- Can ways be considered to obtain one-stop implementation of solutions and faster action? Can the permit process for structures to control erosion be speeded up, particularly in emergency situations?

- Can both study and implementation be directed by a single accountable agency? Can an umbrella type organization coordinate the work and be the source of understandable information? Can the roles of all agencies involved be clearly identified? Will a procedure be established requiring periodic meetings with direction given to the COE?

- To whom do you go for "expert opinion?" Can adequate information about the extent of the problem and possible solutions be made accessible? Can both interagency and public communication be improved?

1.3 EFFECTIVENESS

• What has been accomplished by government agencies since 1973 in dealing with shoreline problems?

- There have been unfortunate results from poor COE studies in the past. For instances, problems have been created in the Delaware Bay System due to COE projects. What will the COE do to the Lake Ontario shoreline?

- Will the COE include the shoreline in any impact analysis done for other projects? This was not done in the Irondequoit Bay Study. Will the COE tell both sides of the issues in this study?

- Will the COE "hold" other projects such as the Port Ontario harbor-of-refuge until it can be assured that the proposed piers will not contribute to erosion? Why did the COE turn down the offer of a free harbor-of-refuge at Deer Creek?

• There should be a timely approach to solving erosion problems. The study time frame is too long. How can the study implementation process be speeded up?

- Can COE recommendations tell Congress that if it wants a study done and the problem solved, it should provide immediate funding? Don't authorize and then not appropriate.

- Can you assure implementation and follow-through on recommendations developed in this study? Will there be a time limit set for action recommended?

1.4 METHODOLOGY

• Data now available is not detailed enough or current enough for decision making. How will this be remedied?

- Is there an inventory of shoreline protection measures (structural and nonstructural) which have been used to control erosion along the Lake Ontario shoreline or the Great Lakes? These should be available to Lake Ontario communities.

- Will the University of Buffalo study documenting the degree of erosion potential for most of the Lake Ontario shoreline be used?

- Can the COE use time sequence photography (at monthly intervals or more frequently) over two full seasons to show local changes including responses to storms? Also visible light photos plus infra-red to study migration by soil types and the influence of river discharge patterns? Will you use current Sea Grant photos and information, as well as historical photo records of recession (Monroe County Planning Department)?

- Will data be coordinated with State CZM work?

- Will the COE determine the degree of erosion caused by man-made forces (e.g., badly constructed breakwalls, IJC decisions on water levels) as opposed to natural forces?

- Can the comprehensive annual recession rates along the entire shore zone be determined and displayed on small scale maps (1 inch = 2,000 feet) showing rates and their location?

2. ENGINEERING

2.1 GENERAL

• Is total structural protection of the shore by the Government a realistic alternative? How will the COE respond to opposition to the use of unnatural measures along the shore zone or the contention that shoreline protection measures that destroy the beach are an unlawful destruction of public property?

- Will the COE examine changes in lake shoreline due to construction of breakwaters (individual and large scale)?

- Will the environmental impact of shoreline structures be considered?

- Can means be developed to protect an entire segment of shoreline since lack of protection in any area may damage adjoining protection?

- Can artificial protection be built uniformly over a large reach of shoreline to specific standards?

- Can COE measures be limited to a less massive scale?

• What are the alternatives for construction on bluffs for access to the shore that will not damage the bluff or increase erosion? Where can such information be obtained?

- Will a system of groins protect cliff areas?

- How can variation in costs between protection of bluffs and other types of shoreline be considered?

• Is the effect of the Niagara ice boom on Lake Ontario being considered? What is the tradeoff between limited flow to maintain ice cover and potential ice jams which would also reduce flows?

• Can the type of protective structure and its location be better matched to make it most effective and avoid waste of time and money? Shoreline protective measures have been poorly constructed. How can this be prevented or controlled? How can quality control be instituted?

- Can the condition of existing shoreline structures, particularly those constructed in the mid-70's be evaluated? (Statement from the town of Porter) Which existing structures can be salvaged? What will be their impacts if repaired?

- Can underwater remnants of old structures be explored as the basis for new breakwaters or groins? Can their stabilization patterns be reinforced rather than establishing new patterns?

- Will maintenance and operation of recommended structural solutions to erosion problems be considered in planning?

- Will the success of structural measures in solving problems be evaluated?

- Can retaining walls be built far enough back so beach is created naturally? Should beach nourishment be encouraged, and should sale of dredged sand be allowed or prohibited?

2.2 LAKE LEVELS

• Have the water levels been higher since the St. Lawrence Seaway was constructed? What has been the effect of the Seaway on levels?

- Were shipping and power the only consideration in the early 1970's? Should these industries contribute to the remedy either by dropping lake levels 4 feet or paying anyone who wants to build a seawall?

- Can we identify problems of industrial users of the lake caused by level fluctuations? What will actually happen to commercial shipping if lower levels are used? Are there examples of groundings due to lower levels?

- Is the view that the Seaway is at fault or causing erosion problems a misconception? Does the Seaway experience damage from high water levels?

- Have water levels been higher on the St. Lawrence since the Seaway was constructed?

- Has a comparative study been done to determine the value of land lost from erosion or flooding versus the cost to dredge the shipping channel and lower the lake levels? Can current lake levels benefiting commercial navigation and power interests be examined to determine if they are too high for the protection of the shoreline?

• Can the COE examine problems created by low lake levels? How is this related to siltation rates in navigation channels?

- Can you measure the effect on lake levels from siltation due to sediment runoff entering the lake from stream flows and the shoreline?

• Will the issue of lake level regulation be looked at from a system perspective, considering the effect on all five lakes? Lakes and levels need to be looked at together. Study of Lake Ontario regulation should be done by the IJC which is doing a similar Lake Erie study.

• Will such studies recognize the international aspects of lake level control and of the downstream and upstream effects?

- Have St. Lawrence riparians received more or less impact from high water, flooding, or erosion than Lake Ontario riparians? Can this be related to regulation?

- How can people be made aware of the impact of lake level regulation on the other Great Lakes? Do residents of the other basins suffer shoreline erosion problems? What is the nature of those problems?

- Can the COE reassess water needs for the power authority and navigation? What are the facts about outflow into the St. Lawrence River? Can we discharge more and if so, who will be negatively affected: riparians on the St. Lawrence, shipping, power?

- Can the effects of high water required by winter navigation on exacerbating erosion rates be examined? (especially in the St. Lawrence River)

- Is there a better alternative for dumping more water downstream without damaging the people downstream?

- How accurately can inflow-outflow volumes be assessed and balanced? Prescribed, computerized? Will study consider both inflow and outflow on all lakes, including impacts of man-made controls?

• We need to know more about lake levels and their effects. There should be a more responsible regime. Can any shoreline protection measures work if the lake is kept artificially high?

- If high levels are determined to be the cause of erosion, what responsibility does the Corps of Engineers have for the control of levels? How can the COE change the present system?

- Can we really control the levels of the lakes, particularly in the spring? If we cannot control levels, why is a new group going to study what has already been studied?

• Will the issue of lake level regulation be considered, including how it is controlled?

• Will the existing criteria be reeexamined?

- Regulated levels have always been over the median. How do you get them to keep their word?

- How likely is it that lake levels will continue to increase? Can they be returned to 1962 levels - 2.2 feet less than at present?

- If the level of Lake Ontario were kept to the low range of permitted variation, would there be any need for massive, unsightly protective devices that have limited usefulness?

- The 1958 orders appear to benefit navigation. Will the orders be changed to require a look at tradeoff for riparian owners? Is private property most affected by high lake levels?

- Lake levels fluctuate too much. Why is such a wide range (4 feet) authorized by the control orders?

- Aren't high lake levels a recent phenomenon and the cause of shoreline erosion?

- Hasn't the present lake level regulation within a 2-foot range disrupted natural processes and allowed dislocation of barrier beaches?

3. ENVIRONMENT

3.1 ECOLOGY

• Can the public be educated to the fact that erosion has always occurred? It happened before controls to regulate lake levels were carried out. Shoreline erosion is a natural process. It occurs through a constantly changing long-term process. Structural measures are really only short-term and present no real solution to shoreline erosion. Should the shoreline be protected?

- Is it reasonable to expect Government to solve all problems, including those caused by nature?

- Will shoreline protection measures that modify the natural erosion process create problems elsewhere on the shore?

- The only two ways to prevent shoreline erosion are to drain Lake Ontario dry or build a "China Wall" from the Niagara River to the St. Lawrence River. Are these acceptable solutions and is anything less only temporarily effective?

- When are we going to stop manipulating the environment? Undeveloped shoreline areas suffer no adverse effects from high levels, but developed property on the shoreline does. Is it the water levels, or is it the position of the property that causes the problem?

• Loss of dunes and swampland, erosion of beach are greatest problems. Water wells have been ruined. Will COE identify whether groundwater is high enough to cause a problem (such as in Irondequoit Bay)?

- Will COE consider conflicts regarding wetlands protection: high levels assist salmonid propagation, but have negative effect on some properties (fishermen vs. riparians); too low levels reduce the area and access for recreation (piers on mud flats, limited access to water, etc.)?

- Are storms on Lake Ontario getting worse each year, causing erosion conditions, heaviest in icing conditions? Heavy ice buildup during the last few years, plus damage from the storm of 1973, has changed the shoreline more rapidly than before. Has cloud seeding affected the precipitation rates in the Great Lakes Basin?

- How much is a loss of vegetation along shoreline, stream banks, a contributing factor to shoreline erosion?

- Will study examine the effect of currents from the Niagara River on erosion?

- How much does the natural phenomenon of seiche or "set up" add to the lake levels problems?

- Define the difference between erosion and flooding.

3.2 GEOLOGY

- Will the lake and shoreline be looked at as a dynamic system where change is to be expected and accommodated?

    - Will the study identify geological processes and erosion rates and determine how much of the problem is caused by natural process and how much is caused by lake level regulation, filling of wetlands, or other specific human actions?

    - How have the barrier reefs and beaches affected littoral drift? What has the construction of shoreline protection structures, dredging, etc. done to the littoral flow? How can this be verified?

    - Where has the sediment gone and what is the rate of loss?

    - What is the relationship of levels to barrier dunes and these to prevention of coastal damage?

    - How can we have more sand and fewer rocks on the beaches?

- Will there be a shoreline inventory for determination of features of natural geologic interest? If a geological feature is unique, will it be exempt from protective measures? (e.g., Chimney Bluffs) Will natural protective shoreline features such as dunes, wetlands, and barrier beaches be identified as such?

    - Will other sites having unique aspects, such as orientation and soil types, be identified?

- Will the geologic structure of the shoreline be identified, for instance, the source of leaching water in bluff areas?

- Bluffs are weakened by seepage. There is a problem with high water tables on some properties and problems with septic leach beds on others. Are there ways of dealing with this problem?

- Erosion problems are occurring in bluff areas due to ice damage and storms undermining the bases of cliffs during periods of high water when the beaches have disappeared. Will this problem be examined?

• Will the study consider the geological fact that the southern and eastern shores of Lake Ontario are submerging at the rate of perhaps a few inches to a foot per century for the last few thousand years and will continue for thousands more? A slowly submerging shoreline retreats in a more or less straight line. Any "shore protection" will protrude as the rest of the shore retreats. Any protrusion will be attacked by more and more wave energy until it is destroyed or becomes an island.

3.3 HAZARD LANDS

• What is the effect of poor land use control on the development of hazard lands in the shoreline area?

- Will the issue of rebuilding structures in the flood plain be examined?

- What are the development impacts of building on natural protective features along the shore such as dunes, bluffs?

- Are dunes being eroded by property owners' building activities, filling, etc.?

- Will the problem of beach loss due to lack of nourishment be studied?

- Will the COE consider key areas to benefit from beach nourishment, and identify loss of beach replenishment sediment from streams?

- There has been loss of beach area - it is available in August, but not otherwise. What can be done about it?

- Under natural conditions prior to regulation, lake beaches reestablished themselves. We should try in a sane way to interfere with nature. Will the COE identify what the tradeoffs are?

- Can we identify the source of sand that is replenishing the beaches, look at damage to residents, but also look at damage to undeveloped dunes?

3.4 FISH AND WILDLIFE

• The inshore waters of Lake Ontario are important spawning and nursery areas for the majority of the lake's fish species. However, insufficient information exists regarding the distribution of fish spawning products to allow precise estimates on the effects of lake level regulation on fish populations. Will the study examine the question, based on our present knowledge, that manipulating lake levels could unduly jeopardize the health of the lake's aquatic resources?

• Will COE consider conflicts regarding wetlands protection - for instance, high levels assist salmonid propagation, but have negative effects on some properties? Destruction of valuable wetlands area is a main problem when considering structural solutions for shoreline development. Consider adverse impacts on marsh birds, waterfowl.

- Will the study identify the wildlife habitats on some shorelines and consider the need for protection from development and structures?

3.5 WATER QUALITY

• Sediment from shore erosion is a pollutant that includes nutrients. How much of a pollution problem is shoreline erosion?

- Will the question of control of runoff from the basin and the impact of present situation on water quality be examined?

• How much of a problem is water pollution from chemical discharges along the shoreline?

• High erosion rates along shoreline is a scheme to cover up polluted sediment in Lake Ontario.

• Will the LOSP Study address potential/actual nonpoint sources of water pollution along the shoreline, including domestic wastewater and sewage disposal, urban runoff, construction sites, inactive landfills, and streambank and roadbank erosion? Will the study recognize the need for more research and monitoring on a watershed basis to identify nonpoint sources and assess their magnitude?

4. SOCIO-ECONOMIC

4.1 GENERAL

• Will the study deal with the problem of lack of trust in Government?

- How will the study identify the social and environmental costs of protection measures?

- What is the relationship of shoreline protection to the area's economy; for instance, the completion of the shoreline parkway?

- The cost of saving property is often orders of magnitude greater than the value of property to be saved. How will this problem be addressed in the study?

4.2 COST/BENEFIT

• Will the cost/benefit analysis for this study be defined to reflect all costs, benefits, and deficits?

- Will local citizens be included in the development of the cost/benefit ratio formula for this study, to obtain input into the formula's factors? Will the COE provided communication with local people on details?

• What kind of relief measures are presently available to shoreline owners to assist with erosion problems?

- Retired riparians have special problems in protecting their shoreline due to costs involved.

- Government financial aid to repair damages and assist with protection of the shoreline is lacking. Will this be considered in the study?

- How much public money was spent after the 1973 disaster? How many people benefited? Would it be cheaper to publicly own the lakefront?

- The $5,000 disaster relief after the 1975 storm was inequitable. Why were funds not allocated by shoreline front footage value of property? Why weren't all areas given definite, alike measures? Neighbors did not have conformity. All properties were given the same amount regardless of frontage and real estate value. Why? There is need for someone to tell a straight story.

- Insurance coverage is not comprehensive enough. National flood insurance does not cover erosion. What are the alternatives?

- Is there group erosion insurance? If not, how could it be developed for shoreline owners?

• At Moon Bay, in the town of Sterling, Cayuga County, several owners have built massive concrete seawalls. They have worked, but cost $160 per foot in 1974. Today, they cost $320 per foot, exceeding our financial capacity. Power and shipping interests should pay for the seawall. Will the study examine this option?

• Let's do nothing" studies have a high cost.

• Will the study show who should contribute to the costs of erosion coastal measures?

- Will funds be available (at very low interest) to repair the shoreline?

- Will Federal grants, not loans, be made available per foot of shoreline for protection?

4.3 TAX POLICY

• Properties are being taxed on their original square footage. Much of the original property may now be under water. The State owns the land under water, but taxes have not been reduced or evaluation changed. Will the question of tax adjustment on land lost to the lake be studied?

- How will the legal and economic effects of paying taxes on land under water be examined? Will this include property reassessment, or a process to allow riparians to declare shore erosion as a tax loss?

- Will original property sizes be checked on tax notices in Jefferson County?

- How will the study consider devaluation of land lost to the lake from erosion?

• Will the study look at tax credits for local private owners who make structural improvements for shoreline protection? Tax adjustments for owner participation?

- There should be a tax rebate for riparians prorated all the years back to the construction date for the Seaway.

- Taxes are high in New York State for resort property. Will the study examine tax relief for "inspected" property?

4.4 RECREATION

• Will the study determine impacts of shoreline protection on recreational interests such as tourism and compare with the benefits and costs of protecting riparians? What about other interests?

- How will the study consider damage done to the shoreline by people, including recreational use and camping? Types of access affect erosion rates. How can access to the lake be obtained without damage to the shoreline? Will the study explore/identify common beach access points to reduce erosion?

- Are recreational interests affected more than seasonally?

• There is a lack of facilities for recreational boating. Will the study explore the need for boating ramps and harbors-of-refuge? (not the one at Port Ontario at the present scale)

- The State has failed to develop for recreation, land it has already acquired in the town of Orleans. The shoreline parkway, for instance, provides no parking for scenic views and no access to the shore. How will the study address this issue?

- Will the question of damage to shoreline esthetics from use of rubble, revetments, etc. be addressed when looking at alternative measures?

- I object to the Government taking over private property for recreation areas. Is there really a need for more State parks on the shore?

4.5 LEGAL

- Will the study determine the responsibility of the riparian owner for protection of his own property?

  - Will the legality of public access on private property be considered? What are the rights of any (nonshoreline property owners) to share access?

  - The beach itself requires definition. Will the study do this?

- Will the laws of boating trespass onto the shoreline be communicated to citizens during the course of this study?

  - Will the impact of controlling motorboats to reduce impact of wave action be considered?

- The fact that local zoning laws are determined by local residents may be a problem. There is a lack of land use restriction or enforcement of existing development restrictions. How will the study examine the need for better enforcement of current laws controlling development?

  - All riparians need to be treated equally and uniformly.

4.6 PUBLIC BENEFITS

- There are controversies about where to locate new harbors-of-refuge. How can the cost of development of harbors be justified? How are these costs related to shoreline erosion?

- If all taxpayers have to pay to protect a few owners who live on the shoreline, the general public should be provided some additional shoreline access. How will this tradeoff be examined?

  - Will the study focus on riparian interests?

  - How can I be assured that my tax dollars go where the public can use the shoreline, lake, and rivers?

- How can the general public from the area be the ones to benefit (from the study) instead of special interests such as commercial groups that don't own shoreline property: hotels, gambling casinos, marinas, etc.?

- Will the study identify desires vs. needs? Many desires are selfish. The result (of the study) should be the best use of land and water resources to serve the community (a balance between public and private interests).

Once you begin to protect shoreline and beaches, you can't stop. Beaches are public property. Beach property owners are not the "general public" but the very few who are responsible for the erosion problems to begin with. Are there interests fundamental to the national interest? How will this problem be addressed?

- How can the individual protect for erosion when the neighbors choose not to?

4.7 SAFETY

Does riprap have to be so ugly and dangerous to walk on from Selkirk State Park to the Pine Grove area?

Will "the COE make a property by property, foot by foot, personal walking survey of the shoreline to observe and document the condition of the existing structural work? Anything less than this will be a continuation of neglect that the town of Porter can no longer tolerate . . . COE should determine whether all the work done under the various 'crash programs' was done, and done in accordance with COE approved plans. We are concerned for the safety of our citizens. The present condition of some of these structures is hazardous . . . they are waiting to kill."

5. REGIONAL PROBLEMS

Many regional problems were identified by workshop participants during the workshops. These are examples of specific shoreline problems to be addressed by the Corps during the study.

5.1 SANDY POND

What will be done to stop destruction of pond area? Solution may be worse than what is already there. A year-round resident for 14 years believes risks should be taken on an individual basis. The issue of commercial development in the area is a major question. Also, with respect to shoreline protection, he is concerned about use of unqualified Contractors doing work with no quality control. Property owners have had unequal access to grants in past - due to poor communication with riparians and availability of grants.

There has been a loss of barrier beaches between Sandy Pond and the lake. The dunes are washing away. There will be no protection for the area

at the north end of the Point. There is new building on the dunes and now less vegetation than before. Consider planting trees, vegetation to retard erosion (beach oak, brush, etc.). Consider beach enrichment. If erosion continues, there will be no land along the lake and the Pond will become part of the lake.

- Can the channel into Sandy Pond be maintained by pumping sand from the Pond and Lake Ontario onto dunes on the beach?

- Could the channel at Sandy Point be stabilized and a harbor-of-refuge created there instead of at Port Ontario? What effect would this have on the erosion forces?

5.2 <u>3 MILE POINT</u>:

• Resident lives on a small bay on south bank of 3 Mile Point. Site has been occupied since 1908 by a farm with 3,000 feet of shoreline. In 1918, a whole area eroded away. A road now ends in water. On the north side of the road, the land area about 100 feet deep by 1,000 feet long was lost to the lake. A 30-foot breakwater went out in the April (May) 1979 storm. What kind of weather warning can be provided? How can aquatic vegetation be used? Can more time be devoted to solving erosion problems? Address issue of high lake level.

• How can we protect our shoreline from erosion that has been going on since we acquired the property in 1916? It seems to be storm and ice caused. It is located at 3 Mile Point in Chaumont Bay.

5.3 <u>WILSON</u>:

• Erosion has been occurring for a long time. Resident's house was moved around 1918. More people now live on the lake. The problem is more visible and there are fewer farms than there were. He has lost 300 feet of property since 1918. How much of a problem is caused by siltation? What is the volume of water which must be accommodated? (Displacement of water due to siltation? What effect does this have on levels?) More development alongshore at Wilson, Olcott, Willow Beach, 18 Mile Creek, Oak Creek, etc. What effect has this had on runoff, increase in siltation, etc.?

5.4 <u>SELKIRK BEACH</u>:

• Salmon River, breakwater at Selkirk Beach. There are so many problems. Environmental concerns: preservation, protection of Deer Creek Marsh - wetlands are eroding away, dunes being eroded by property owners with building activities, filling, etc. Did the Selkirk State Park piers change the flow of water to accelerate erosion north of there? Will the study look at nonstructural, long-term solutions?

5.5 <u>RAMONA BEACH</u>:

• Resident has lived there since 1946 full time. His land is higher than his neighbors. He wants action now, not 17 years from now. Has lost

property and his well. (An "Indian well" where lake water filters in from the beach.) He has no drinkable water any more; price of a new well is high.

5.6 HENDERSON HARBOR:

• Need for possible repair and rebuilding of the West Breakwall area and surrounding areas of the CUT Snowshow Point, Henderson Harbor, NY, as it has deteriorated quite badly over the past 10-12 years due to increasingly severe year-round storms - especially winter ice conditions. What type of breakwall is needed and what type of assistance is available? The issue is somewhat complex as it involves public access (to the harbor) through a private breakwall. The water level in the area surrounding the CUT has become lower each year, earlier each season. Moss and algal buildup have appeared earlier each year. Has the temperature of the lake changed due to power plants and pollutants? The property on which the breakwall is located belongs to a Mr. Walker from Watertown, NY, and the breakwall in question (the CUT) is the channel leading from Henderson Bay into Lake Ontario. The breakwall area is a very popular shoreline fishing area for those who do not own boats or who can get away for only a few hours. Shoreline fishermen use this area heavily, and fishermen are from Watertown, Camp Drum, Rochester, and tourists. NYDEC conducted surveys during 1978 of users, and may have additional facts. This should be explored.

5.7 OTHER AREAS:

• The Port Ontario breakwater will cause changes at Deer Creek Marsh (also Salmon River) and is not adequate to hold boats for recreational use of the harbor. Will this be studied?

• Could a seawall be built on Moon Beach shoreline?

• Could damage to 12 Mile Creek area from authorized dredging be corrected with jetties?

• The abandoned Hojack Line bed at Eastman Beach in Rochester area has the beach intact. If proposals to cut down the bank to improve visual access to the beach are successful, the beach area will be lost. The area is under the jursidiction of the Monroe County Parks Department. How will the study deal with this problem?

• Will the COE identify the impact of the proposed harbor-of-refuge at the mouth of the Salmon River and evaluate the impact on erosion of the shoreline north of the proposed pier?

6. ALTERNATIVE MEASURES

6.1 STRUCTURAL MEASURES

6.1.1 System-wide

• Can a joint project be initiated with Canada to study the feasibility of widening or dyking sections of the St. Lawrence channel (downstream of the

Moses-Saunders power dam)? It would be constructed in Canada, but would provide significant benefit to the USA shoreline residents. Water can then be dropped to a safer level.

- Why can't we lower the level by modifying the St. Lawrence outfall?

- What is the possibility of placing additional generators at Moses-Saunders to replace loss of water volume due to lower levels?

• Build a large sluiceway in the Seaway so that at time of high levels on the lake, an additional amount of water could be let out of Lake Ontario. This would be a joint U.S.-Canadian venture and should not endanger people along the St. Lawrence.

- Construct a diversion system as on the Mississippi.

- Consider finding an alternate relief outlet such as an aqueduct to the Hudson.

• The LOSP study should consider the alternative of using energy conversion from wave energy as shoreline protection. Use a hydrodynamic breakwater about 2,000 feet out from shore. The cost of the breakwater would be self-liquidating. Shore erosion is checked, valuable land and real estate are not destroyed, and insurance rates would not go down. The stilled water on the lee side would allow vegetation to become established and fish population will increase. It could also stimulate aquaculture for much needed food. Recreation potentials are enhanced and waters are safer for smaller, less energy intensive boats. This also provides the potential for preestablishing a marine coastal shipping industry to save truck diesel, etc.

• Consider whether changing the littoral drift by changing the current at the mouth of the Niagara River would result in less shoreline erosion.

• Should some of the lake ports be relocated? Has an analysis of this been done in terms of providing lower lake levels? (joint Canadian-U. S. study)

6.1.2 <u>Site Specific</u>

• Study should emphasize local headlands protection. These would protect many small local coves with small beaches. As headlands erode, coves and beaches disappear. It would seem to be cost effective at least to begin any structural work with a concentration upon these.

• Consider use of concrete V structures such as used on Lake Michigan to build beaches.

• Consider use of automobiles encased in concrete as riprap.

Examine the use of movable systems such as tires tied together, etc. which are not as cost prohibitive and are not necessarily a sin you'd have to live with (if they don't work).

Use a lakewide series of jetties. This would be very expensive.

Stabilize the clay bluffs along the entire shoreline as they are particularly susceptible to erosion.

- Another factor affecting the erosion along the lake shore including storm related erosion damage, is that most of the structures and other man-made areas are old and have been neglected over the years. Since storms and high water take an easier toll of these, will the study examine this factor?

6.1.3 Lake Level Regulation

The primary concern of the study should be regulation of lake levels with consideration of riparian owners. Lower the lake levels by law. Property owners should then be responsible for their own shoreline protection and natural processes would rebuild the shoreline.

- Lake levels should be kept in the lower level of the permissible range - 242.7-246.7 - to prevent flooding.

- Lower the lake in late winter to avoid spring high levels.

- Let out maximum amount of water from the lake in spring and summer.

- Lake levels should be reduced in the fall.

- By 15 December, the lake should be regulated to its lowest level.

- Lower level of Lake Ontario by 6 inches on 15 June 1980.

- A drop of 1 foot in regulated levels would produce results.

- Lake levels should be regulated to the middle level (mean) of the range between 242.6 and 246.8.

Is it possible to forecast precipitation fluctuations more accurately and then modify more effectively the peaks and valleys of lake levels? Forecast the level of Lake Erie and lower Lake Ontario before it becomes too high (from Lake Erie inflows).

- Don't want to hear again the "If we hadn't regulated the lake levels, erosion damage would be a lost worse." It isn't true.

6.1.4 Technical Assistance

- Can the COE provide aid in the form of technical advice to the individual for protecting the shore? They should not otherwise get involved in construction of protective structures for individual landowners, but only for major structures.

  - Can the COE determine what protective maintenance is required - what works, how erosion can be prevented?

  - Can various alternative structures be demonstrated?

  - Can questions be answered such as: It is more effective to place rocks offshore as a breakwall or onshore as riprap, and, are there other ways besides railroad tie breakwalls to prevent erosion?

- If public monies are used for shoreline improvements on private property, the COE should impose minimum construction and maintenance standards and provide technical assistance and supervision to accomplish this.

  - Will the COE develop design criteria and a construction review process?

  - How will shoreline protection Contractors be regulated, educated?

  - Will the study examine the questions of enforceable standards for protective devices, shoreline "protection districts" with mandatory participation, and Federal-State agency coordination in developing and administering programs such as these?

  - Will COE consider the review or development of a protection plan for each property owner, assisting with selection of a Contractor, inspection of construction before final payment is made, and the provision of other consulting services to property owners?

6.2 NONSTRUCTURAL MEASURES

6.2.1 General

- Nonstructural solutions are best in the long run. Land use changes over time require changes in solution. The study should consider central control vs. local control.

  - There needs to be better definition and broader coverage under the National Flood Insurance program. Flood hazard insurance based on identified flood hazard areas should be issued.

  - Relocate residents away from shoreline at Government cost.

- Control all-terrain vehicles and keep them off the dunes and beaches.

- Will the study look at long-term nonstructural solutions?

- Will the study identify abusive land use practices and their relationship to erosion, impact on wetlands, etc.?

• Will the study consider revegetation of affected areas? Plant beach grasses and use fences to trap and stabilize dunes. Riprap can be useful but only if particle size is quite large. Most riprap is too small to be effective and can be dangerous to beach use. They are using crown vetch, trefoil, and birdfoot to bind soil to bluff.

• The concept that lakeshore property owners should be restricted from selling their land or allowing it to be inherited should be studied as an alternative with evaluation of its impacts.

6.2.2 Land Management

• Some shoreline management policies should be mandatory and enforceable. There should be no building in high erosion-prone areas, or in wetlands (including smaller parcels than presently protected under State law), due to the cumulative effects of development of wetlands.

- The State should restrict development in erosion hazard areas as proposed in the CZM plan. New development should be prevented by the use of zoning and other nonstructural measures.

- As an alternative, those constructing along the shoreline should be required to file an environmental impact statement to show the effects of the proposed action. This should be simple and include information about septic tank permits and permit action.

- Can local governments enact erosion zoning to prohibit building too close to the shoreline? Zoning should include setback requirements. It is least costly, most feasible, but must be based on reliable data.

- Develop a uniform building code (locally oriented) for erosion control by structural or nonstructural remedies. Include provision for enforcement and amendment.

• Adopt the philosophy of author Orrin Pilkey: "No erosion problem exists on the shoreline until a structure is built on that shoreline . . . construction disturbs the delicate equilibrium and often is in itself a cause of shoreline changes . . ."

- According to COE figures, lake levels have been high since 1952. There has been major development along the shoreline since 1950, with subdivisions and other intensive uses creating enormous amounts of runoff into the lake. The impact of this runoff in

accelerating erosion and siltation should be considered. How much of the shoreline erosion/flooding problem is due to accelerated runoff from development?

- Will the study investigate the contribution of poor agricultural practices in siltation and accelerated erosion of the shoreline? These should be documented.

- There should be control of projects or activities that contribute to shore erosion such as the Hojack Line drainage from the south side of Irondequoit Bay.

6.2.3 Public Acquisition

• There is too much shoreline in private hands. Public access should be looked at as a nonstructural solution to erosion control. Will the study consider use of transfer of title, right of first refusal and transfer of development rights to obtain public ownership of shore?

- Purchase of development rights will prevent hazardous development, more intensive development, and preserve environmental quality for the future.

- The State should: invoke the law of eminent domain so all shoreline property becomes public; have right of first refusal to purchase shoreline property for recreational access; purchase endangered property when it comes on the market; acquire the land between parcels it already owns to improve public access.

7. COST-SHARING

• Gabions seem to be the most feasible structural solution. However, some type of low interest loans or revolving loan fund should be made available to property owners. This should only occur in areas where erosion is occurring at a slow rate and thus would warrant public subsidizing. No Federal/State subsidies should be given to property owners in areas where erosion is occurring at a very rapid rate. A determination of a cutoff point for deciding feasibility should be made during the COE study.

• Under Article 12 of the NYS General Municipal Law, communities can create shoreline protection districts. This allows construction of structural measures with cost going to property owners within the district. This involves no new bureaucracy and should be a primary tool advanced by any Corps study.

• Provide Federal and State money to assist in the development of shoreline protection structures.

- As an alternative, would the cost be lowered if compensation were paid to riparian owners for State ownership of protection measures?

- Consider making Government liable to riparian owners for damage resulting from lake level regulation.

- Consider making shipping and power interests pay costs of high water levels by premium on cargo or tax on windfall profits from cargo hauled due to high water.

- Use grants to aid in relocation.

- Use money from this study, others, to assist riparian owners protect their property.

- Institute a class action lawsuit to collect costs of shoreline damages.

- Use Government work projects such as CCC to assist in building, maintaining shoreline protection.

- Use revegetation to control erosion with cost-sharing such as Soil and Water Conservation Districts have available.

- Study should consider allocating costs by foot frontage.

- Since shoreline erosion damages the shoreline investment and pollutes the lake, it is in the Government interest to cost share to prevent this.

- Should all taxpayers have to pay to protect a few owners who live on the shoreline?

APPENDIX C

U.S.F.&W.S.

PLANNING AID LETTERS

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
100 Grange Place
Room 202
Cortland, New York 13045

February 7, 1980

Colonel George P. Johnson
District Engineer, Buffalo District
U.S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Colonel Johnson:

This planning aid letter is intended to assess the potential impacts on the fish and wildlife resources of Lake Ontario and its shoreline that may result from the use of the structural and non-structural shore and shore property protection measures identified in the Scope of Work for the Lake Ontario Shoreline Protection Study. Also to be considered in this letter are the further studies, if any, that will be needed to carry the project to more advanced planning stages. This letter has been prepared in fulfillment of the third requirement of the Scope of Work for the Lake Ontario Shoreline Protection Study. It provides technical assistance only and does not constitute the report of the Secretary of the Interior on the project within the meaning of Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

The structural shore and shore property protection measures identified in the Scope of Work include bulkheads, seawalls and revetments, vegetation, offshore breakwaters, beach nourishment, groins, berms and levees, floodproofing, setbacks and relocations, and modifications to the outlet of the St. Lawrence River. Nonstructural measures include re-regulation, coastal zone management and zoning, insurance, tax adjustments, and public purchase and easement. Since no specific plans for shore and shore property protection have been developed at this time, we can only present general, qualitative impacts that may result from the use of measures recommended in the Scope of Work. When detailed plans are proposed, the use of specific measures in specific areas will still have to be considered on a case-by-case basis.

Bulkheads, Seawalls, Revetments, and Vegetation

Bulkheads are vertical retaining walls, usually constructed of timber or steel sheet piling, that are placed along the shoreline to maintain it in a fixed position. Seawalls are massive concrete structures, often used to protect shorelines subject to wave erosion in storms. Revetments are facings, frequently of stone, used to protect a shoreline embankment from erosion.

Construction of shore protection devices such as bulkheads, seawalls, and revetments can result in the removal of shoreline vegetation which may have been serving as natural shoreline protection. Construction activity can increase erosion and sedimentation in the vicinity of the new structure and disturb bottom areas. Additional habitat destruction can result during the construction phase if backfill for the structures is obtained by dredging. When dredged material is used for backfill, three acres of submerged sediments are required for each acre of filled land. Consequently, the U.S. Fish and Wildlife Service does not condone dredging merely to obtain backfill. When completed, this type of shore protection device can eliminate or greatly reduce in quantity and quality valuable habitat such as shallow inshore areas and the shore/water interface. The vertical walls of these structures also create reflection waves which further disturb sediments and any habitat which may develop at their base in the future. Groups of inappropriately placed structures can create anaerobic cul de sacs. Shorelines adjacent to these structures will continue to erode, exposing the flanks of the protected areas to additional damage.

Stone revetments (riprap), if properly constructed, may provide more long lasting protection and may be less susceptible to ice and storm damage, while providing increased surface area for benthic organism habitat.

Vegetation can provide a means to protect the shoreline in a relatively cost effective and environmentally acceptable manner. It can be used to stabilize erosible shoreline areas while maintaining or enhancing aesthetic qualities and reducing effluent and nutrient flow from shore.

Some sections of the Lake Ontario shoreline may have inherent problems associated with them such as steepness or seepage that would preclude the establishment of vegetation for shoreline protection. However, in many areas vegetation could provide an alternative to costly constructive methods or be used in conjunction with such methods. Additionally, existing vegetation should be maintained, where possible, to take advantage of its established protective capabilities.

A more innovative use of vegetation as shoreline protection involves the development of marsh and aquatic plant growth along unprotected stretches of shoreline. Establishment of vegetation in this manner would provide natural, protective breakwaters along with valuable, functioning wetland habitat.

Breakwaters are rock or concrete structures placed parallel to the shoreline in offshore waters to protect shoreline areas from wave effects. Breakwaters are also used to form artificial harbors to provide safe dockage facilities.

Breakwaters alter and interrupt water circulation patterns which can result in the downdrift erosion of shore areas. They may also disrupt or eliminate benthic habitat, depending upon the type of construction used. Benthic habitat may be increased if the breakwater is of riprap-type construction. Breakwaters should be properly planned and constructed to provide recreational access for hunters and fishermen.

A variation of the standard breakwater is the "headland." Construction of offshore headlands out of riprap would provide benthic habitat. Properly located and constructed headlands along the segment of shore experiencing erosion due to wave action should result in the formations of spits or tombolos behind the headlands. The shoreline should stabilize with the formation of crenulate-shaped bays. These types of structures are being considered for Presque Isle, Pennsylvania, Lake Erie. For more information on headlands see Coastal Engineering, 2, Sedimentation, Estuaries, Tides, Effluents, and Modeling, by R. Silvester, 1974. Elsevier Scientific Publishing Co., New York.

Beach Nourishment

Beach nourishment consists of supplying moveable material, usually sand, to the beach area for the absorption of the energy of waves and currents. Addition of sand to the beach zone eliminates organisms in that area until reinvasion can occur. Since beach nourishment is by no means a permanent method of shore protection, frequent maintenance through the addition of more sand is necessary. Consequently, areas are unable to recover from these frequent perturbations.

The area from which the nourishment sand is removed may also be adversely impacted. If sand is removed from offshore areas, this may cause the waves to impact the shore with greater force, thus increasing the erosion potential. In the Lake Ontario region there may be no convenient sources of sand available or those that are available, such as the dunes on the eastern shore, would be unacceptable sources.

Groins, Berms, and Levees

Groins are rock or concrete structures, placed perpendicularly to the shoreline, whose function is to cause the accretion of downdrift materials. Groins interrupt the longshore current and lateral transport of beach sand. This results in the upstream accumulation and the downstream erosion of materials. As additional barriers are added, they merely transfer the erosion process further downstream.

Berms and levees are embankments, usually of earth, used to prevent flooding. Depending upon where such structures are placed, they can have varying impacts. If placed in upland areas to protect buildings from high water, impacts should be minimal. However, if they are placed in wetland, littoral, or land/water interface areas, such habitat could be destroyed or unacceptably altered.

Floodproofing, Setbacks, and Relocations

Floodproofing consists of altering flood-prone buildings to make them more resistant to floodwaters. In the case of Lake Ontario, buildings would more realistically have to be stormproofed to eliminate a larger amount of the damage that occurs. Such measures would probably not have any adverse impacts on fish and wildlife but they would serve only to treat the symptoms and not the cause of damages that are a result of construction in hazard prone areas. Relocation of buildings in these hazardous areas would represent the only long-term solution to the problem of flood and storm damage.

Setbacks and relocations of shoreline property provide an opportunity to establish such property out of high risk erosion and flood areas. Shoreline property is protected without the construction of structures that may adversely impact fish and wildlife habitat. However, buildings must not be setback or relocated into areas where fish and wildlife values are high.

Outlet Modifications of the St. Lawrence Seaway

Modification of the outlet to the St. Lawrence River would undoubtedly involve the construction of a control structure at the outlet. Such a control structure would be used to further modify the water levels of Lake Ontario. However, adequate structures already exist further downstream on the St. Lawrence River. The environmental impacts that would result from such an outlet modification would be unacceptable as well as unnecessary in light of the existence of other similarly functioning structures. The State of New York has already indicated that it would be unacceptable to them to modify the outlet to the St. Lawrence River.

Re-regulation

Closely related to structural modifications of the outlet to the St. Lawrence River is the re-regulation of Lake Ontario water levels. As previously indicated, that capability is available now in the form of existing dams at Waddington and Massena, New York. Water levels have been higher than normal in recent years on Lake Ontario, and from all indications these increases are due to man's activities, can therefore be expected to continue, and may require further regulation of lake levels.

Re-regulation of Lake Ontario water levels may also necessitate increasing the existing channel capacity of the St. Lawrence River. Several alternatives are now being considered for channel modifications to the river and will involve the excavation of 4.9 to 22.0 million cubic yards of material in the Chimney Point to Morrisburg section of the river. The U.S. Fish and Wildlife Service has already expressed opposition to similar dredging proposals in the St. Lawrence River that would be necessary for the Navigation Season Extension Program. Consequently, we could not look favorably upon these channel modification proposals for the Lake Ontario Shoreline Protection Study.

Coastal Zone Management and Zoning

The New York State Coastal Zone Management Plan is nearing completion and is beyond the point where constructive input can be made that would result in major changes in the plan. Important habitat areas have been identified through the CZM process and plans have been advanced to protect these designated areas from development.

At this point, it seems more likely that shore protection through zoning will have to come from local efforts. Movement and the establishment of buildings out of hazard prone areas will attack the erosion and flooding problems at their source and will provide protection without vast amounts of construction. The shoreline protection study presents an excellent opportunity to encourage the development of local zoning ordinances to protect the natural shoreline and regulate future development.

Insurance

Insurance that is designed to cover the damage property owners receive from high water, floods, storms, erosion, etc., merely serves to subsidize continued development in such hazardous areas. It does not encourage persons to relocate out of these areas. Consequently, decreasing insurance coverage and/or increasing rates should be used as a temporary measure only until development can be moved out of damage-prone areas.

Tax Adjustments

There are two potential ways to use tax adjustments in the management of coastal areas. Preferred land use can be encouraged by levying preferential tax rates. For example, taxes can be deferred or waived if the land is maintained in a natural state or if construction meets predetermined standards either through construction methods used or through the location of buildings on the property. Such tax breaks could encourage speculative landholding so penalties would have to be instituted for land that is later sold profitably for development purposes.

Tax incentives can also be given to property owners who receive damage due to "natural" causes. However, this procedure, like insurance, encourages maintenance of the status quo. Tax breaks of this sort should only be used as temporary measures until shoreline development is moved out of hazardous areas.

Public Purchase and Easement

Public purchase is a good way to protect valuable habitat, especially that which is in imminent threat of destruction. However, purchase can be very costly and there may be opposition to the public acquisition of private lands. Easements are a less expensive and less offensive means of protecting valuable lands and can achieve results similar to purchase.

In the preceeding paragraphs we have attempted to indicate our understanding of each shore and/or shore property protection method and the impacts, particularly on fish and wildlife resources, that may be associated with them. We cannot, however, give a blanket endorsement to any of these methods, structural or non-structural.

Each area of the shoreline must be examined in detail and shore protection methods must be designated specifically for the area. Generally, non-structural protection such as the promotion of vegetative cover would be the most environmentally desirable method. In a few high energy areas with an adequate sand supply, offshore riprap headlands may be acceptable. However, our review of these methods can only be viewed as a preliminary assessment, based on generalizations and no specific engineering plans. As such plans are developed to further define plans for the Lake Ontario Shoreline Protection Study, more specific statements on the suitability of protection methods, from the fish and wildlife standpoint, can be made.

The Lake Ontario Shoreline Protection Study is only one of several proposed projects to modify or study the Great Lakes system and that will have an impact on Lake Ontario. The Lake Ontario Shoreline Protection Study in particular should be closely coordinated with current International Joint Commission (IJC) proposals. The IJC is presently investigating the feasibility of Lake Erie water regulations (International Lake Erie Regulation Study Board) which would also impact Lake Ontario, further Lake Ontario regulations are being considered (International St. Lawrence River Board of Control), and the impact of diversion and consumptive uses on water regimes is being evaluated (International Diversion and Consumptive Uses Board). In addition to the above IJC evaluations, the Corps of Engineers is examining modifications such as the twinning of the locks in the St. Lawrence River and the enlargement of the navigation channels throughout the connecting waters of the Great Lakes.

We are not recommending any site-specific studies at this time as we do not have any site-specific measures upon which to base them. There is, however, an attempt being made at this time to obtain congressional authorization to fund a biological characterization of Lake Ontario and the St. Lawrence River. This characterization will be designed to collate and analyze the existing data on these systems. Upon completion of this characterization, our knowledge will be more well-defined and we will be better able to identify those areas which need further study and where future study funds can be most wisely spent.

Therefore, at this time, we are not recommending any specific biological studies for the Lake Ontario Shoreline Protection Study. We feel it would be more prudent to wait until the proposed characterization is complete and then proceed to develop the necessary shoreline investigations.

Sincerely yours,

Paul P. Hamilton

Paul P. Hamilton
Field Supervisor

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
100 Grange Place
Room 202
Cortland, New York 13045

August 30, 1979

Colonel George P. Johnson
District Engineer, Buffalo District
U.S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Colonel Johnson:

This planning aid letter is intended to provide an identification and discussion of problems, needs, and opportunities associated with the fish and wildlife resources of Lake Ontario and its shoreline in satisfaction of the second requirement of the Scope of Work for the Lake Ontario Shoreline Protection Study. Our letter provides technical assistance only and does not constitute the report of the Secretary of the Interior on the project within the meaning of Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

In many cases, particular problems, needs, and opportunities associated with the Lake Ontario Shoreline Protection Study are very closely related and can most readily be discussed in conjunction with one another. A problem, once identified, frequently generates very obvious needs and opportunities that can best be considered as one unit. Where appropriate, problems and their associated needs and opportunities will be discussed together in this planning aid letter.

A major problem associated with Lake Ontario and its shoreline is the effect that the present and historical regulation of lake water levels has had on the natural environment. Such regulation and the subsequent alteration of water levels has affected fish and wildlife habitat. The type, degree, and impact of the alteration is relatively unknown and unstudied, but there is enough information to know that some of the alteration has been adverse to fish and wildlife habitat. Consequently, the effects of present and past lake level manipulations on fish and wildlife resources and their habitats need to be investigated. This information can then be used to develop a water level regulation plan that is most advantageous to the natural environment.

Another serious problem that exists is the lack of basic biological information for the Lake Ontario shoreline. As we indicated in our first planning aid letter, the natural resource information available for the lake is very limited with only a small fraction of the shoreline having been characterized in any comprehensive manner. Without such baseline resource information, it becomes difficult or even impossible to adequately assess impacts that may result from the implementation of any of the structural or nonstructural erosion and shoreline flood protection measures proposed in the Lake Ontario Shoreline Protection Study. The lack of basic resource data also makes it difficult to identify problems, needs, and opportunities associated with the Lake Ontario shoreline except in the very broadest terms.

The lack of adequate resource information points out a need associated with the fish and wildlife resources of the Lake Ontario shoreline. A comprehensive biological characterization of the area must be done. The collection of comprehensive baseline biological data will (1) provide information necessary to assess possible environmental impacts, particularly those associated with regulation, erosion, and shoreline flood protection measures; (2) greatly facilitate the preparation of accurate habitat maps of the shoreline, including submerged areas; (3) aid in the identification of habitat areas of particular importance to fish and wildlife resources; (4) aid in the identification of more specific problems, needs, and opportunities associated with the fish and wildlife resources of the Lake Ontario shoreline; and (5) be used in conjunction with historical lake level data to determine the impact that lake level regulation has had on fish and wildlife resources and their habitats.

Closely associated with the need for more information on the Lake Ontario system is the need to compile all such information into a systematic and readily accessible form. Such a compilation should include that information which presently exists as well as that which will be obtained through future studies. Past experience has shown that much of the presently available information is scattered throughout many sources that are sometimes difficult to obtain and often require large inputs of time and effort to obtain what limited information exists. To make the greatest use of resource information as it becomes available there needs to be a central repository for such information.

The Lake Ontario Shoreline Protection Study presents an excellent opportunity to conduct the recommended and necessary biological and water level regulation studies and to compile all this information into a systematic and useable form. Since it is a study of the entire shoreline and is to deal with problems associated with the shoreline, this opportunity to study the natural resources of the area should be pursued in as timely a manner as possible in order that the information gained may be used to assess the environmental validity of potential shore protection proposals.

Another major problem associated with the fish and wildlife resources of Lake Ontario and its shoreline is the loss of habitat. Habitat is most frequently lost in small bits and pieces, each project being responsible for a seemingly insignificant loss. However, the cumulative impact of all such small projects is highly significant to the ecosystem.

Whether in large or small pieces, important and increasingly valuable fish and wildlife habitat, including wetland and littoral areas, is being impacted by development activities. It is very likely that with increased affluence and leisure time more areas will be developed in the future, further affecting fish and wildlife habitat.

Development along the Lake Ontario shoreline has occurred in a relatively haphazard manner without enough consideration given to impacts on fish and wildlife resources and their habitat. Once it has been determined that a given water level regulation plan would be of the greatest benefit to the natural environment then a need obviously exists to develop a plan to control the nature and extent of future shoreline development. A properly designed and implemented land use plan could reduce the loss of and help preserve valuable fish and wildlife habitat. The results of biological and water level regulation studies could be used to determine those land use practices and planning and zoning regulations that would most benefit fish and wildlife resources.

The Lake Ontario Shoreline Protection Study provides an opportunity to innovatively direct future shoreline development in a manner that would be most beneficial to fish and wildlife resources. In addition to instituting some form of land use planning in the coastal zone, other measures relating to the shoreline and the conservation of its natural environment could also be adopted. Property owners along the shoreline could be encouraged to use methods of property development that provide the required service but cause the least environmental damage. For example, the use of seasonal structures rather than permanent ones, community facilities rather than private ones, and riprap and gabions rather than concrete or steel bulkheads should be encouraged, or required, where practical.

Other opportunities could also be integrated into habitat preservation and accompanying land use planning. A buffer zone could be established along the shoreline within which no commercial or residential development would be allowed to occur. This would prevent encroachment into valuable fish and wildlife habitat while preventing further problems associated with shoreline construction. Tax advantages could also be enacted that would encourage individuals to leave their land in a relatively undeveloped state, thus maintaining fish and wildlife habitat.

Habitat loss could also be attenuated through public acquisition, either by purchase or easement, of particularly valuable habitat areas. The baseline biological studies would identify those areas that should be acquired because of their valuable nature.

These are the types of solutions to shoreline development and protection problems that should be pursued in this study.

We appreciate the opportunity to provide input at this stage of the Lake Ontario Shoreline Protection Study. If you would like to further discuss the ideas put forth in this letter, please do not hesitate to contact us.

Sincerely yours,

for John T Hickey
Paul P. Hamilton
Field Supervisor

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
100 Grange Place
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Cortland, New York 13045

JUL 16 1979

Colonel George P. Johnson
District Engineer, Buffalo District
U. S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Colonel Johnson:

This planning aid letter is intended to provide an existing conditions profile of Lake Ontario and its shoreline in satisfaction of the first requirement of the Scope of Work for the Lake Ontario Shoreline Protection Study. It will include a presentation of available information regarding wetlands, embayments, islands, shoals, littoral areas, and tributaries found in this area. However, the natural resource information that is available for the Lake Ontario shoreline is very limited in nature; there have been few, if any, detailed studies of shoreline habitat. Therefore, the information presented in this letter must be recognized as being a compendium of that limited information which presently exists and not a comprehensive inventory of shoreline resources. There are large gaps in the information that do not provide even a basic indication of the resources present. Only a small fraction of shoreline habitat has been characterized in any way; large areas are completely unexplored. Consequently, with the type of information available at this time, it would be difficult or impossible to assess potential impacts resulting from shoreline or water level modifications. System-wide studies of the lake and its shoreline would be necessary before impacts could be adequately assessed.

Our existing conditions profile of the natural environment of Lake Ontario and its shoreline provides technical assistance only and does not constitute the report of the Secretary of the Interior on the project within the meaning of Section 2(b) of the Fish and Wildlife Coordination Act.

General Description

The Lake Ontario shoreline from the mouth of the Niagara River in the west to Tibbett's Point at the head of the St. Lawrence River in the east is approximately 290 miles long. The shoreline extends in a generally east-west direction from the Niagara River for about 160 miles and is fairly regular in configuration. It then turns to a north-south direction for the remaining distance, becoming generally irregular in conformation with several large bays along it.

The east-west portion of the shoreline consists of bluffs of glacial material that are 20-60 feet high. The bluffs are subject to erosion by wave and other action. Erosive forces are particularly active in the Great Lakes Region due to the relatively young geologic age of the area. Gravel beaches border the bluffs; these remain rather narrow due to the fineness of the material eroded from the bluffs. The Rochester and Irondequoit Bay areas are marshy with sand and gravel barrier beaches separating marshes and open ponds from the lake. From Sodus Bay to Port Ontario, there is a series of high drumlins and dunes separated by low marsh areas. Drainage in drumlin areas is often poor, resulting in the formation of wetland areas in association with them. These marsh areas often extend inland for some distance, following tributary streams. There is an area approximately ten miles in length near the Oswego County-Jefferson County line that is composed of sand and barrier beaches. Above this area, the shore changes to rock outcroppings with indentations formed by several large embayments.

The lake consists of two major areas: the eastern or northeastern basin and the central-western basin. The eastern basin, which encompasses approximately 10 percent of the surface area of the lake, has more relatively shallow areas than the central-western basin, contains numerous islands, shoals, and bays, and has almost the entire sportfishery and most of the commercial fishery in the lake. Only a small portion of the central-western basin contains the shoals and protected bays that are particularly favorable for inshore sportfishing.

Prior to 1875 Lake Ontario and its tributaries supported a large population of Atlantic salmon which was important to the subsistence of Native Americans and early settlers who harvested them annually during the fall spawning run. The most significant spawning and nursery areas along the south shore of the lake were the Salmon River system and Deer Creek. The deforestation, damming, and tannery pollution attendent to the early settlement of the area destroyed these and other streams as salmon habitat and the species rapidly declined. Despite attempts to restore salmon through artificial propagation, the last important runs occurred

in the late 1870's, though a few adults were seen as late as 1897. In the late nineteenth century, the lake also supported a thriving commercial fishery for lake trout, lake whitefish, lake herring, bloaters, and burbot. This fishery and a later one for blue pike declined as the supporting fish populations virtually disappeared in the early twentieth century. The last significant landings of lake trout and blue pike occurred in the early 1940's. The most important factor in the decline of lake trout and the Coregonines was overfishing. The sea lamprey - unreported before 1875 - gained importance as a decimating factor as the populations of its primary targets, the most desirable commercial species, were severely reduced. In addition, inshore habitat destruction and pollution may have eliminated important spawning areas for whitefish, lake herring, and blue pike.

The decline of these and other species plus the introduction of new species has resulted in the establishment of an unstable fish community. Lakewide the most abundant fish are currently three exotic species - alewife, rainbow smelt, and white perch.

Unlike the deepwater and pelagic fish communities, the inshore fish community has remained relatively stable. Inshore areas are populated by yellow perch, smallmouth bass, northern pike, bullhead, rock bass, sunfish, and white perch. These areas have supported and continue to support a productive sportfishery, particularly in the eastern basin of the lake.

Recent attempts to restore salmonids to the lake through control of the sea lamprey and stocking have had encouraging results as evidenced by the rapidly developing sportfishery for brown trout, rainbow trout, coho and chinook salmon, and lake trout. The salmonid fishery received a temporary setback when unacceptable levels of Mirex and PCB's were found in certain fish species in 1976. In 1976 a ban was placed on the possession and consumption of certain Lake Ontario fishes, including salmonids; this ban was replaced in 1978 with a warning of possible dangers associated with consumption of these fishes. Stocking of coho and chinook salmon was eliminated (except for some stocking of cohos for monitoring purposes) following the 1976 ban. Consequently, the sportfishery for these species will be reduced for several years but New York State resumed its stocking program in 1979. In addition, there is strong evidence that remnant populations of burbot, whitefish, and lake herring are responding favorably to the sharp decreases in abundance of the sea lamprey.

Though it is well-known that the life cycles of the major species of the lake dictate a reliance upon the shallow, inshore waters, particularly the bays and estuaries, little specific knowledge of the location and importance of spawning, nursery, and feeding areas exists.

The Great Lakes Basin is probably more important to waterfowl than has been acknowledged. The Basin is a particularly important link in migration between the southern United States and Canada. It has been estimated that:

76,000-250,000 diving ducks use a migration corridor along western Lake Ontario.
26,000-75,000 diving ducks use a migration corridor along central Lake Ontario.
76,000-250,000 diving ducks use a migration corridor along eastern Lake Ontario.
31,000-100,000 dabbling ducks use a migration corridor along central and eastern Lake Ontario.
25,000-75,000 Canada geese use a migration corridor along western Lake Ontario.
5,100-25,000 Canada geese use a migration corridor along west-central Lake Ontario
75,000-150,000 Canada geese use a migration corridor along east-central Lake Ontario.
5,100-25,000 Canada geese use a migration corridor along eastern Lake Ontario.

These migration corridors are also used by hawks, passerine birds, and waterbirds to an unknown extent.

There are important nesting and migration areas in central and eastern Lake Ontario while there are wintering and/or migration areas in eastern Lake Ontario. Eastern Lake Ontario and the St. Lawrence River are important areas for the production and harvest of many dabbling and diving ducks.

Niagara River

The Niagara River, which drains the upper Great Lakes, is the major tributary to Lake Ontario with a flow of approximately 202,000 cfs. Much of the area along the river is heavily developed by industry, especially the chemical industry, and consequently the river suffers from a high degree of pollution. Contamination is also caused by leakage from chemical waste disposal sites in the vicinity of the river.

Despite the heavy industrial development and resultant contamination of the river, it remains an important waterfowl and waterbird area. The river supports moderate resident populations of mallard and black ducks. It is also an important loafing and feeding area for waterfowl (including ducks, geese, and whistling swans) during migration and a wintering area

for scaup, goldeneye, old squaw, and canvasback ducks (canvasbacks are generally declining in numbers throughout their range). The river has become a migration terminus for waterfowl and waterbirds due to the discharge of thermal effluent into it and the resultant formation of ice-free areas in a normally thoroughly frozen environment. However, problems which can result from such heavy use in winter include: lack of food production and cover, the potential for oil and hazardous material spills, and outbreaks of avian disease. Areas that are particularly noted for their waterfowl concentrations include Strawberry Island (canvasbacks), the west side of Grand Island, Cayuga Island (canvasbacks), west of the North Grand Island Bridge (mergansers), the entire river from the Lewiston-Queenston Bridge downstream to Lake Ontario, the gravel bar along Joseph Davis State Park (mallard, teal, and other puddle ducks), and to the north, west, and south of Old Fort Niagara.

Colonies of ring-billed gulls and black and common terns are found west of the North Grand Island Bridge. Goat Island is a herring gull rookery. Waterbirds, such as ring-billed, herring, bonaparte, glacous, Iceland, and great black-backed gulls and caspian and common terns, are observed utilizing gravel bars along Joseph Davis State Park.

There is a wooded gorge along the Niagara River downstream from the falls. It provides good habitat for nesting hawks, particularly red-tails. Herons are also found in the gorge area and are being adversely affected by human fishing activity.

Fisheries resources in the upper Niagara River include muskellunge, smallmouth bass, northern pike, rainbow and brown trout, coho salmon, yellow perch, rock bass, and walleye. The shoal areas and marshes around Grand Island and all the tributary streams entering the river in this vicinity are spawning areas for northern pike and muskellunge. Strawberry Island is also a prime muskellunge spawning area; northern pike spawn in the area near the North Grand Island Bridge. Smallmouth bass, yellow perch, and rock bass also spawn in the upper river. It must be said for this and all other segments of the Niagara River that only a limited number of spawning areas are known. There are undoubtedly many other major spawning areas that have not yet been identified as such.

Rainbow and brown trout, coho and chinook salmon, northern pike, American eel, rainbow smelt, brown bullhead, white bass, white perch, and yellow perch are found in the lower river. The mouth of the river is a productive littoral area which provides excellent feeding, spawning, and rearing

grounds for yellow perch, smallmouth bass, largemouth bass, rock bass, long-nose gar, carp, lake trout, and other species. It is also a good northern pike spawning and panfishing area.

There is an area off the mouth of the Niagara River in Lake Ontario that is known as the Niagara Bar. It is an area that has historically been a prime spawning area for lake trout. Consequently, this is an important area that must be left undisturbed if lake trout are to re-establish their use of it.

Fishery resources in the entire Niagara River could be jeopardized not only by chemical contamination but also by changes in water levels. Excessive demand by industries and municipalities could eliminate shallow water areas used by many species for spawning, feeding, resting, and protection. Lake level regulation could also be detrimental to the fishery if artifically high or low levels are maintained or if release schedules are not synchronized with the life cycles of aquatic species.

Despite the current level of pollution existing in the Niagara River, a fine fishery still exists. If pollution control measures are instituted and the river is significantly cleaned up, a superb fishery could be established.

Niagara County

The Niagara County shoreline extends for approximately 34.4 miles eastward from the mouth of the Niagara River. The shore is lined with bluffs 30-60 feet high composed of glacial till and layered drift. The bluffs are open to attack by wave, frost, and seepage action and surface erosion. Very little of the eroded material remains in the beach zone due to its fine consistency. For this reason, beaches in Niagara County are very narrow. These bluffs are subject to severe erosion, sometimes resulting in land losses of up to five feet per year.

The shoreline in Niagara County is primarily in private ownership and is used most frequently for permanent and seasonal residences. Agriculture is important in upland areas. There are four State Parks, Fort Niagara, Fourmile Creek, Tuscarora, and Golden Hill, along the shoreline that were just recently acquired for long range needs. There are also federal small boat harbors at Wilson and Olcott.

There are a number of tributary streams entering Lake Ontario along the Niagara County shoreline. Proceeding from west to east, the first of these tributaries is Fourmile Creek. There is an embayment at the mouth of the creek that gradually becomes a wetland approximately 1/4 mile upstream. There is a gravel barrier beach at the mouth of Fourmile

Creek that virtually eliminates free flow to the lake; there is, however, some intragravel flow. During years of highwater, there are spring and fall salmonid runs. Northern pike spawning occurs in the creek. Other fisheries resources include smallmouth bass, largemouth bass, yellow perch, brown bullhead, and several varieties of sunfish.

Waterfowl, especially goldeneye and bufflehead, use the Fourmile Creek area; also found there are mallard, canvasback, redhead, and scaup. There are some areas upstream that provide good songbird habitat, particularly an undeveloped portion of Fourmile Creek State Park.

Sixmile Creek is similar to Fourmile Creek in that free surface flow to the lake has been cut off due to the formation of a gravel barrier beach. An approximately 16 acre wetland has developed upstream. There are fall salmonid movements and northern pike spawning in this stream.

Twelvemile Creek and its east branch are considered to be a major fisheries resource stream. There is spawning habitat for northern pike and smallmouth bass. Tuscarora Bay, which is formed at the east branch outlet, has the best brown trout fishing in the region and also provides spawning habitat for northern pike and smallmouth bass. Coho salmon and rainbow, lake, and brown trout concentrate in the lake around the mouth of Twelvemile Creek and its east branch. There is also sportfishing for brown bullhead, black crappie, largemouth bass, yellow perch, and northern pike. Waterfowl, including mallard, black duck, teal, and wood duck, and furbearers also use the area. It is the location of the federally-maintained Wilson Harbor.

Hopkins Creek provides no free flow to the lake due to a sand and gravel barrier beach. There is a shallow, marshy embayment that extends about 1/4 mile inland. The area provides waterfowl habitat.

The first two miles of Eighteenmile Creek are another major fisheries resource stream as a high quality sportfishery exists there. It is the location of the federally-maintainted Olcott Harbor. Water quality in the lower reaches of the creek is moderate, sediments in the inner harbor are polluted while those in the entrance channel are unpolluted, and macroinvertebrates are generally low in numbers and diversity. Tubificid worms, which are pollution tolerant organisms, are the most abundant macroinvertebrates.

The creek provides spawning habitat for brown and rainbow trout, coho and chinook salmon, northern pike, and smallmouth bass. The creek is vitally important to the maintenance of a viable smallmouth bass population in this region of the lake. Smallmouth bass is limited in its occurrence in western Lake Ontario and there are not many spawning sites available. The area in Eighteenmile Creek may be the largest single spawning site for smallmouth bass in Niagara County. Other gamefish recorded in the creek include largemouth bass, walleye, bullhead, black crappie, pumpkinseed, rock bass, bluegill, and yellow perch. Brown trout, coho salmon, and to a lesser degree chinook salmon and lake and rainbow trout, concentrate at the mouth of Eighteenmile Creek.

The marshes along Eighteenmile Creek are predominated by cattails and serve as good alluvial habitat for muskrat, mink, weasel, raccoon, and red fox and as a concentration area for mallard, black duck, American widgeon, lesser scaup, wood duck, blue-wing teal, green-wing teal, pintail, and Canada goose. Ring-necked pheasant have also been observed in these marshes.

Keg Creek has no free flow to the lake due to shoaling. An embayment has formed at the mouth. There are spring runs of steelheads in years of highwater, northern pike spawning areas, and good populations of other warmwater fishes.

Fish Creek has minor salmonid movements and some spawning habitat for warmwater fish. Areas adjacent to the creek provide good furbearer habitat. Golden Hill Creek also has a gravel barrier beach which has caused an embayment with accompanying wetland habitat to establish upstream. The littoral area at the mouth of the stream concentrates geese and puddle ducks during spring migrations. There is some minor use of the wetland by black duck, mallard, blue-wing teal, and wood duck for nesting, resting, and feeding. It also provides refuge for waterfowl during storms. Muskrat also make use of the wetland. A limited sportfishery exists for brown bullhead, yellow perch, largemouth bass, northern pike, and carp.

Orleans County

Orleans County is directly east of Niagara County and has about 24 miles of shoreline. The shoreline consists primarily of bluffs of glacial till that are 20 feet or higher. Beaches are composed of sand or gravel with a maximum width of 30 feet. Generally, beaches are too narrow to provide shoreline protection and consequently bluffs are eroding where they are not protected. Approximately half the shoreline is developed residentially while the remainder is in open space, agriculture, and parks.

The littoral area from the mouth of Oak Orchard Creek (Point Breeze) to Onteo Beach in Monroe County is an important goose concentration area. Included in this extended area, in the vicinity of Oak Orchard Beach, are important feeding and resting areas for shorebirds. Among the shorebirds using this area are three species, the buff-breasted sandpiper, black-bellied plover, and golden plover, that are relatively rare for this portion of New York. A very significant spring fishery for brown, rainbow, and lake trout and coho salmon exists in the nearshore areas of Orleans, Monroe, and Wayne Counties.

The first tributary to enter Lake Ontario along the Orleans County shoreline is Marsh Creek. Its channel is blocked by sand and gravel at least part of the year. A small embayment has formed at the mouth which becomes marshy in upstream areas.

There is a gravel bar in the center of the mouth of Johnson Creek which results in two outflows. This is considered a major resource stream as there are fall runs of coho and chinook salmon and spring runs of white sucker.

Oak Orchard Creek is another major fisheries resource stream. It is an excellent smallmouth bass spawning and nursery stream and also provides a significant fall chinook salmon run, accompanied by rainbow and brown trout. There are two power plants located upstream and the creek was channelized for more than 11,000 feet in 1975. Marsh Creek is a branch off Oak Orchard Creek that has coho and chinook salmon runs.

Monroe County

Much of the Monroe County shoreline is low and marshy. About 20 miles of westerly shoreline has low marshes with barrier sand and gravel beaches. The easterly portion of the shoreline has silt and clay bluffs up to 55 feet high with beaches less than 30 feet wide. From the Orleans County line to Hamlin Beach State Park, the shoreline is identical to that found in Orleans County. From Hamlin Beach State Park to Rochester, the shoreline is low marsh with barrier and sand beaches. The Rochester to Wayne County line segment has silt and clay bluffs up to 55 feet in height. Much of the shoreline is used for residential purposes (about 20 miles) and much is protected.

Yanty Marsh has formed upstream in Yanty Creek due to the formation and separation of an embayment by a sand and gravel bar from the lake. It is a concentration area for puddle ducks, especially teal, gadwall, and black ducks. The littoral zone off the marsh is also an important goose concentration area.

Sandy Creek is a major resource stream with a shallow embayment at the mouth and gradually becoming marshy upstream. It is an excellent smallmouth bass spawning stream. The mouth of the creek, known as Straight Lake, is a productive area for smallmouth bass and northern pike. Stocking has produced an excellent fall fishery for coho and chinook salmon and brown trout.

The area in the vicinity of Hamlin Beach State Park has an excellent nearshore fall brown trout fishery.

A marshy embayment at Brush Creek is separated from the lake by a sand and gravel bar which allows no free surface flow to the lake. Most of the marsh is protected by the state as a wildlife management area.

Ponds at Shore Acres were previously important shorebird feeding and resting areas. Due to high lake levels, the habitat has become unsuitable for such uses, but the area could be restored. The littoral area between Shore Acres and Wautoma Beach gets heavy usage by migrating geese.

Rose's Marsh provides excellent habitat for puddle ducks, shorebirds, passerine birds, and furbearers. It supports cattle egrets, American egrets, snowy egrets, little blue herons, and yellow-crowned night herons, all of which are unusual species for western New York State. Black ducks and wood ducks also nest here.

The Montour Beach littoral area has spring concentrations of puddle ducks, whistling swans, northern phalaropes, and king eiders.

Braddock Bay is the first major embayment along the Lake Ontario shoreline and is the last large undeveloped shallow water marsh west of Rochester. Salmon and Buttonwood Creeks feed into the bay. Salmon Creek has supported a good fall chinook and coho salmon fishery. Long-eared owls nest upstream on Salmon Creek. The bay supports a largemouth bass and northern pike fishery while there are large concentrations of white perch along the shoreline. The shallow waters of the bay provide a nursery for northern pike, walleye, largemouth bass, yellow perch, brown bullhead, black crappie, and sunfish.

There are extensive wetlands along the perimeter of the bay and the tributary creeks. Some of these areas are protected as wildlife refuges in Braddock Bay State Park. There are nesting mallard, black and wood ducks, blue-winged teal, snipe, and marsh hawks in the marsh area. Virtually all species of dabbling ducks found in New York State use the bay. Rough-legged hawks are observed in late fall and winter while

short-eared owls overwinter. Bald eagles, golden eagles, osprey, peregrine falcons, and broad-winged, sharp-shinned, red-tailed, red-shouldered, marsh (Northern harrier), and Cooper's hawks are seen frequently in migration. Due to the large numbers of raptors that pass through the Braddock Bay area, it has become a prime location for the observation of such birds by birdwatchers. In the 1920's and 1930's bald eagles nested in the bay, while in the early 1970's there were resident non-breeding ospreys. The bay marshes have a historical importance to pheasant populations as they provide excellent escape cover. Furbearers, such as muskrat, mink, and raccoon, are common.

Cranberry Pond and Long Pond are very similar. There are concentrations of red-breasted mergansers, American mergansers, goldeneyes, and buffleheads in the area. Common nesters include mallard, wood duck, and blue-winged teal. The ponds provide important feeding and spawning areas for northern pike, bass, walleye, pickerel, and panfish.

Black Creek provides spawning and nursery areas for smallmouth bass.

Buck Pond is separated from Lake Ontario by a sand and gravel bar which has eliminated free flow to the lake. Larkin Creek feeds into the pond. Much of the pond's perimeter is marshy and the pond itself is relatively shallow. The wetland supports moderate waterfowl and furbearer production. The area is also a stopover point and early wintering area for waterfowl such as red-breasted and American mergansers, goldeneye, and bufflehead ducks, but the concentratons in Buck Pond do not equal those found in Cranberry and Long Ponds. Blue-winged teal, black duck, and mallard are common nesters in the surrounding wetlands while rails, gallinules, herons, and bitterns use the area for feeding. There is a wet, wooded area east of Buck Pond that concentrates small birds during migration, some of which are unusual for the New York region. Unusual species occurring here include the least bittern, red-headed woodpecker, Carolina wren, and cerulean warbler.

Round Pond is also separated from the lake by a sand and gravel bar and is fed by Round Pond Creek. The pond is relatively shallow and much of it is wetland. Fish and waterfowl production has decreased in recent years due to pollution and encroachment into the area. The pond still, however, supports populations of northern pike, pickerel, bass, bullhead, and panfish.

Little Pond, which is fed by Slater Creek, receives a power plant thermal effluent discharge which attracts warmwater fishes, salmonids, and herons to the pond. A portion of the pond is not accessible to the

public as it is the property of the New York State Electric and Gas Corporation. The New York State Department of Environmental Conservation is purchasing Rochester Water Authority property which will provide access to pond and shoreline fisheries.

The Genesee River is maintained as a commercial harbor and is an intensely industrialized area. The river has been severely polluted, but apparently water quality has improved as excellent smelt runs occurred in 1978-1979 and good spring and fall salmonid runs occurred to the first barrier. There are areas upstream that have the potential to be developed as an urban "wilderness" park due to the presence of vacant, overgrown lands and wetlands. In addition, in 1971 a bald eagle, a Federal and state endangered species, nested on the river about 15 miles south of Rochester.

Irondequoit Bay is a major embayment along the Lake Ontario shoreline. The bay is oriented in a north-south direction and is approximately four miles long and 1/4-3/4 miles wide. Except for a narrow shallow outlet, a barrier beach separates the bay from the lake. There is little water exchange between the bay and Lake Ontario so it functions more like a lake than a bay.

Much of the bay is surrounded by steep slopes rising up to 150 feet above the water's surface. Wetlands comprise about ten percent of the area around the bay. These wetlands are primarily small and scattered with the only large contiguous area located in the south of the bay along Irondequoit Creek. There are about 474 acres of wetland surrounding the bay with 320 of these acres comprising the wetland at Irondequoit Creek. These wetlands may have value as spawning habitat for northern pike and as cover for juvenile fish. Large concentrations of puddle ducks utilize these wetlands. The area is particularly important to blue-winged teal, mallard, and wood ducks; some black ducks nest in the area.

Irondequoit Bay is highly eutrophic. Studies of the bay have concluded that severe degradation of water and sediment quality have diminished the diversity and quality of aquatic life. Aquatic vegetation was at one time much more widespread. It has, however, been reduced as a result of filling activities, reduction in water clarity, and changes in nutrients. Benthic organisms present are primarily those tolerant to pollution. However, the remaining wetlands, primarily those in the south bay area near the mouth of Irondequoit Creek, have helped to somewhat reduce nutrient input from the creek.

White perch and alewife are the most abundant fish species; they are also the most abundant spawners. Brown bullhead, pumpkinseed, and largemouth bass are the only sportfish that spawn in the bay. The potential does exist for an extensive sportfishery of salmonids as salmon and rainbow trout enter the bay during spawning migrations. There is presently a very good run of steelheads in Irondequoit Creek. In addition, Irondequoit Bay has historically been a smallmouth bass spawning area.

The central and southern portions of the bay are used by scaup, scoter, and, rarely, harlequin ducks for wintering and during migration. Mergansers winter in northern bay areas.

Wayne County

The Wayne County shoreline from the Monroe County line to Sodus Bay consists of a continuous bluff, ranging from 10-70 feet in height, and averaging 25 feet. The bluffs consist mainly of silt and clay. The beaches are about ten feet wide and consist of coarse gravel and shingle.

From Sodus Bay to Little Sodus Bay there are a series of drumlins that are separated by marshes. These wetlands often extend several miles inland along tributary creeks. The drumlins may be up to 150 feet high and in many instances they are eroding.

Agriculture is the primary land use along the 37-mile Wayne County shoreline. There is also some residential development. Where the shoreline is unprotected there is significant erosion.

Salmon Creek forms a large embayment at its mouth called Maxwell Bay. The bay has significant waterfowl and shorebird value. Puddle ducks, herons, and bitterns use the bay and wetlands. The creek has fall and spring runs of salmonids; warmwater species occurring include smallmouth bass, yellow perch, brown bullhead, and rock bass. Smallmouth bass spawn in Salmon Creek. There are bank swallow colonies and American chestnut trees found in the area adjacent to the creek.

Great Sodus Bay is a federally maintained harbor and is commercially developed. It is a concentrating point for waterfowl during migration. Widgeon, black duck, mallard, green-winged teal, pintail, canvasback, and redhead are seen regularly in migration. There is an excellent fall salmon and trout fishery, a tremendous spring salmonid fishery for brown, rainbow, and lake trout and coho salmon, and a superb warmwater fishery, including largemouth bass. Other warmwater fishes present

include northern pike, smallmouth bass, walleye, rock bass, yellow perch, white perch, brown bullhead, sunfish, crappies, and numerous forage fish. Brown bullhead, smallmouth bass, alewives, and some minnows spawn in the bay. The bay is fed by several small streams, the first two of which are sea lamprey spawning streams. Sodus Creek is stocked with coho and chinook salmon and rainbow trout and is also a spawning stream for sea lamprey.

Lotus beds have been identified in Great Sodus Bay. This is an unusual plant species for upstate New York.

Rock Swamp is under state ownership as a Wildlife Management Area. It is particularly valuable as it is essential habitat for pileated and red-bellied woodpeckers.

East Bay is fed by several small tributaries and is separated from the lake by a sand and gravel bar resulting in little free surface flow. The bay and surrounding wetlands are used by pintail, widgeon, and shoveller ducks in migration. Black duck, wood duck, blue-winged teal, common gallinule, and American bittern nest in the bay while redhead and canvasback ducks overwinter. The bay also provides good habitat for muskrat, mink, and raccoon with beaver present in the upper areas. Fish species found in the bay include bluegill, black crappie, brown bullhead, largemouth bass, rock bass, and carp; there are smelt runs in spring.

Port Bay is also fed by several small tributaries. The wetlands at the head of the bay are state-owned. The bay is entirely littoral and is a spawning area for smallmouth bass.

Red Creek has a marshy embayment at its mouth that is separated from the lake for most of the year by a barrier beach. There are other wetlands among the high drumlins. Largemouth bass use the area. The surrounding wetland areas are in state ownership and support muskrat, weasel, and fox populations.

Black Creek has a marshy embayment at its mouth and is separated from the lake by a barrier beach that allows no free surface flow. The area provides good wood duck habitat.

Blind Sodus Bay is fed by Blind Sodus Creek. It is separated from the lake by a barrier beach. It is a walleye spawning area with walleyes up to 20 pounds having been taken from the area. Smallmouth bass, rock bass, and crappies also spawn in this bay. There is some waterfowl use.

The entire littoral zone from Smoky Point to Bootleggers Point is a concentration area for waterfowl. Loons and grebes overwinter near the plume from the Ginna power plant. Geese also gather in the plume in spring. Smallmouth bass and brown trout concentrate in the plume during winter months.

Cayuga County

The shoreline of Cayuga County is about eight miles long and consists of a series of drumlins separated by marshes extending several miles inland along creeks. The shoreline is subject to significant erosion if left unprotected.

Little Sodus Bay is a federally maintained small boat harbor. Consequently it is rather well-developed commercially. There is a major warmwater sportfishery in the bay based on species such as northern pike, smallmouth bass, largemouth bass, walleye, rock bass, yellow perch, white perch, brown bullhead, crappies, sunfish, and numerous forage fish. Spawning areas exist for brown bullhead, alewives, and some minnows. Salmonid activity is increasing in the bay due to state stocking programs for coho and chinook salmon, brown, rainbow, and lake trout, and splake.

Sterling Creek and its major tributary, Sterling Valley Creek, have formed large estuaries which are bordered by wetlands for several miles inland. The Pond ("Sterling Creek Pond") and the estuaries are important spawning areas for Lake Ontario bullheads, smelt, and rock bass. Just upstream are significant smallmouth bass spawning and nursery areas. Important resident species include northern pike, largemouth bass, and sunfishes. A popular sportfishery for bullheads, smallmouth bass, smelt, rock bass, and Lake Ontario salmonids exists here alongshore, at the stream mouth, in the Pond, and upstream. The stream mouth and The Pond lie within Fair Haven Beach State Park.

Juniper Pond is an isolated lake-level pond and marsh separated from the lake by a gravel barrier beach. It contains 12.8 acres of open water plus an equivalent amount of wetland. Resident fish include bullheads, pickerel, largemouth bass, and minnows. Wildlife is abundant in the area.

Ninemile and Eightmile Creeks both have marshy embayments at their mouths. Each is utilized by Lake Ontario bullheads, smelt, smallmouth bass, and rock bass as spawning and nursery areas. Both creeks receive runs of salmonids, including rainbow trout and coho and chinook salmon.

Oswego County

Oswego County has a shoreline length of approximately 35 miles within which are contained some of the most significant fish and wildlife habitats along the south shore of Lake Ontario. Most notable are the estuaries of the Little Salmon River, the Salmon River, Butterfly and Deer Creek Marshes, and North and South Sandy Ponds. The first five miles of shoreline that extend to the City of Oswego consist of a series of drumlins separated by marshes extending several miles inland along tributary streams. The first 13 miles of shoreline to the east of the City of Oswego consists of bluffs 5-25 feet high with gravel and shingle beaches up to 30 feet in width. From this point to the Salmon River there are occasional reaches of high ground separated by marshes fronted by barrier beaches (similar to drumlin formations to the west). North of the Salmon River is an area of barrier beach with sand dunes up to 45 feet high that separate marshes or open ponds from the lake.

Significant erosion occurs if the shoreline is unprotected. Average annual recession rates have been as high as 2.4 feet per year. Applications for permission to build shoreline protection have increased dramatically in recent years and now much of the shoreline is artificial. For example, 37 percent of the Oswego County shoreline and 28 percent of the North Sandy Pond shoreline has been modified.

Health Camp Marsh is approximately 36 acres in size and is separated from the lake by land. It is located in the most westerly portion of the county. About three quarters of the marsh is open water with patches of open marsh in the south supporting stands of aquatic emergents such as arrowhead, arrow arum, and the free-floating duckweed. The northern section of marsh is densely populated with speckled alder and buttonbush. Health Camp Marsh is an important nesting area for the red-bellied woodpecker and the barred owl. It is also a potential nesting area for the red-shouldered hawk. This marsh is particularly valuable due to its diversity of habitat types.

Snake Creek Swamp is a marshy embayment of about 130 acres formed at the mouth of Snake Creek. The marsh is separated from the lake by a barrier beach. There is open water, two to four feet deep, throughout the marsh. The area provides excellent duck habitat, supports many marshbirds, and has a high mammal diversity.

Rice Creek has formed a marshy embayment at its mouth due to its separation from the lake by a barrier beach. Cattail and arrow arum are two predominant plant species. Nearby areas have been developed for human recreation and seasonal housing. There is a high diversity of fish species in the creek but the area in general is not too important for mammals and birds.

There is a federally-maintained commercial harbor in the Oswego River at the City of Oswego. The surrounding area is highly developed with commercial and industrial enterprises, some of which contribute pollutants to the harbor area. Included in this development are numerous operational and proposed electric generating stations powered with fossil and nuclear fuels. Harbor sediments are highly polluted. Oil spills are always a possibility due to the oil-fired power plants in the City. In the past, many waterfowl used the harbor area in winter as it was kept ice-free due to the discharge of heated effluent from these power plants. This use by waterfowl may be reduced or eliminated in the future as heated effluent is no longer consistently discharged within the harbor area.

A small embayment of approximately 3.5 acres has formed at the mouth of Wine Creek. The embayment is separated from the lake by a barrier beach and is shallow and marshy.

Teal Marsh is part of the Milea Beach area. It is approximately 30% shrub swamp and 70% wooded swamp. Buttonbush is the dominant plant species. The barrier beach has been recreationally developed. The Showy Lady Slipper is found in Teal Marsh and is protected by state law. The marsh also has a high mammal diversity and provides habitat for many wetland breeding birds.

A 19-acre embayment has formed at the mouth of Otter Branch Creek. It is separated from the lake by a barrier beach and is shallow and marshy. At Catfish Creek there is a 24 acre embayment that provides good northern pike and largemouth bass fishing. Some areas in the embayment are marshy. The creek receives spawning runs of bullheads, smelt, smallmouth bass, rock bass, rainbow trout, and chinook and coho salmon. The inshore area of the lake near the mouth of Catfish Creek is a productive sportfishing area. Major species taken are smallmouth bass, brown and rainbow trout, and chinook salmon.

An embayment of Butterfly Creek forms the approximately 560-acre Butterfly Swamp. The area provides excellent waterfowl hunting and fish and wildlife cover. It is an important spawning and nursery area for bullheads and northern pike. There are unique hemlock-covered dune complexes in the wetland. Several parallel dune "islands" are about 120 feet from the lake shore in western Butterfly Swamp. The dunes are dominated by 120-year old hemlocks; there is also some tupelo on the dunes. Some logging is occurring on one of the dunes. Excessive amounts of logging could result in destruction of the unique dune system. The swamp is very important habitat as bobcat have been reported in the area, marsh birds breed there, waterfowl use the area in migration and in winter, and the area could be utilized by bald eagles and red-shouldered hawks if they reoccupy the area.

The Little Salmon River flows into Mexico Bay in the southeast corner of Lake Ontario. There is a breakwall at the mouth of the river and the area has been developed for recreational access. A shoal sometimes develops at the mouth of the river and prevents the passage of small craft. Spy Island, a site of historic importance, is located in the river near its mouth and is surrounded by wetlands that prevail along the entire length of the river. This wetland is part of a complex that includes those wetlands associated with Sage and Butterfly Creeks. Approximately 40% of the wetland is shallow fresh marsh and 40% is wooded swamp. Great blue herons, green herons, mallards, kingfishers, long-billed marsh wrens, and swamp sparrows have been identified as breeding in the marsh. Other waterfowl, particularly goldeneye and bufflehead, rest and feed in the area.

The Little Salmon River is classified as a Class I salmonid stream. Other important fish in the river include yellow perch, walleye, brown bullhead, and white bass. Smallmouth bass spawn in the river.

A 40-acre embayment that is primarily wetland has formed at the mouth of Sage Creek. The area has excellent production for furbearers and waterfowl. There are also good largemouth bass, bullhead, and northern pike fisheries. Fifty acres of shore in this area at Derby Hill have been preserved through purchase by the Onondaga Audubon Society. Derby Hill is an important bird migration area. Consequently, it is a popular birdwatching location. Green herons are known to roost and nest in the area while great horned owls and red-tailed hawks nest here also.

Snake Creek enters Lake Ontario in the Ramona Beach area. There is a 68-acre embayment at the creek mouth that is primarily wetland and is known as Ramona Beach Marsh. This area provides good waterfowl and furbearer production. There is a black tern colony in the area and it is also heavily used by migrating birds. There is also much beach erosion and summer home development in the area.

Grindstone Creek is a part of Selkirk Shores State Park. The creek is a Class 1 salmonid stream. It is also an important bullhead, smelt, and smallmouth bass spawning and nursery stream. There is a 130-acre embayment at the mouth of the creek, much of it marsh. The area is an important nesting, resting, and feeding area for waterfowl and marshbirds.

The Salmon River is another important fisheries resource stream entering Lake Ontario. The fish in the area have a richness and diversity seldom observed in freshwater habitats. This is largely a result of the differences in habitat occurring in the area. Three habitat types are represented in the area, including: Lake Ontario; Selkirk Lake, an embayment at the mouth of the river; and the river itself. Potentially, 76 species of fish may occur in the river. In a recent study, 43 species of fish were collected using a variety of capture techniques. The most abundant game fish include salmons, trouts, pikes, basses, panfishes, and perches. Abundant forage fishes include golden shiner, white sucker, creek chubsucker, alewife, and other shiner. The Salmon River complex is an important spawning and nursery area for a great many Lake Ontario fish species. It is a major sportfishing area for both warm and cold water fishes as is the inshore area of the lake near the mouth of the river.

Extensive wetlands in the area support populations of waterfowl, waterbirds, reptiles, amphibians, and mammals.

The area of Oswego County north of the Salmon River may represent the most valuable segment of not only the Oswego County shoreline but of the entire Lake Ontario shoreline. This area comprises the barrier beach-sand dune complex, unique to this part of the shoreline. The dunes were formed thousands of years ago when the level of Lake Ontario had stablized 30-40 feet lower than it is today. Conditions no longer exist that will allow the dunes to replenish themselves if disturbed; once they are removed they will be gone forever. The dunes protect the wetlands behind them from potentially damaging wave action, serve as landfalls for stressed birds migrating over Lake Ontario, and serve as migration corridors for birds that fly along the lake.

There are typically two types of dunes present along this shoreline segment. There are stabilized dunes which are vegetated with a pine-oak shrubby underbrush. There are also active or primary dunes, vegetated with pioneer species such as beach grass and tailed wormwood. Wildgrape, cottonwood, and choke cherry may be found growing on the more stable areas of active dunes. The fauna of the dune areas is poor due to harsh environmental conditions and consists primarily of invertebrates, shorebirds, some songbirds, and in some more stable areas, a few small mammals.

Sand is currently being mined for foundry purposes from the dunes and construction and traffic on the dunes are thwarting natural vegetational succession that serves to stabilize the sand. It is very likely that current land use practices in the dune area could result in the destruction of an exceptional natural resource.

The Deer Creek wetland, with an area of 1325 acres, is the largest in the county. A wetland has formed at the mouth of the creek and is separated from the lake by sand dunes. These dunes serve to maintain the integrity of the wetland. The dunes are presently being impacted by sand mining and recreational uses. The dunes could eventually move inland, filling in the marsh in the process. This area has long been recognized as one of the most productive and ecologically sensitive marshes along the eastern end of Lake Ontario.

There is a great variety and quality of habitat in Deer Creek Marsh. It includes shrubby thickets of willow, alder, and dogwood; expanses of sedges and grasses; mixed forest areas; and open water. Such habitat diversity results in a high level of fish and wildlife production potential. The marsh is particularly important to waterfowl and waterbirds. It is a breeding area for mallard, black duck, blue-wing teal, killdeer, spotted sandpiper, common snipe and red-breasted merganser. The marsh is a migrational stopover point for goldeneye, scaup, bufflehead, old squaw, gulls, golden plover, greater yellowlegs, ruddy turnstone, Hudsonian curlew, dowitcher, upland plover, gallinule, American egret, and cormorant. It is possible that the endangered bald eagle could become re-established as a nesting species in this area. Northern pike, bullheads, smelt, and rock bass spawn in Deer Creek Marsh while smallmouth bass and salmonids migrate through the marsh to spawning and nursery areas upstream. The marsh is also important for large numbers of reptiles and amphibians, deer, fox, mink, and weasel. The state has recently acquired Deer Creek Marsh and it is now a wildlife management area.

There is a bog area found near the southeast end of South Pond. Typical bog vegetation of spagnum moss, bog rosemary, leatherleaf, large cranberrry, and pitcher plant are found here. South Pond is a breeding area for the marsh hawk (Northern Harrier).

North Pond is a unique area that is fed by Skinner, Lindsey, and Little Sandy Creeks. The pond and its tributaries support a variety of important game fish, including northern pike, black crappie, brown bullhead, yellow perch, smallmouth bass, largemouth bass, and naturally reproducing rainbow trout. North Pond is important habitat for yellow perch as it is the principal spawning area for yellow perch in all of Mexico Bay. All of the tributary creeks are Class 1 salmonid streams. Skinner Creek has a naturally reproducing population of coho salmon. Therefore, fishing in the area is excellent. The pond is protected from the lake by a barrier beach. Dunes along the southern end of the pond are about 90 feet high while those on the northern end are about 70 feet high. The dune area is, however, being destroyed by recreational activities and seasonal housing development. Large numbers of gulls and terns concentrate in the area from April through December. Carl Island is located in North Pond. It is a small island, only ten feet above the pond level, and therefore subject to periodic flooding.

Jefferson County

The southern shoreline of Jefferson County consists of a series of flood ponds. These flood ponds are shallow depressional areas, separated from the lake by a continuous sandy beach (up to 45 feet high). They are hydrologically connected to the lake by subsurface seepage or through the stabilized outlets of tributary streams. The northern portion of the county's shoreline is cut by a series of bays of variable size. There are some flood ponds in this section but wetlands are most frequently found in the shallow waters of protected bays. Bays such as Henderson and Chaumont provide important habitat for warmwater fishes. The smallmouth bass fishery in this area is one of the most productive of its kind in the state. Despite the importance of this fishery, little or nothing is known of specific areas where the smallmouth bass spawn.

The wetlands and their associated habitats are particularly important to the maintenance of fish and wildlife populations in the St. Lawrence-Eastern Lake Ontario region. They provide essential spawning and nursery habitat for native warmwater fisheries. The wetlands also provide nesting, feeding, and resting areas for migratory waterfowl.

In 1972 over 51 percent of the land along the shoreline, and for one mile inland, had been converted to agricultural or developed land use. This percentage was substantially higher directly along the shoreline. Another indication of the degree of development in this area is shown by the 34 percent of the shoreline of Chaumont Bay that has been artificially stabilized and protected.

Cranberry Pond, and its accompanying marsh is a flood pond system that is separated from the lake by a sandy barrier beach. Water flows from the pond to the lake through an earthern dam. A shallow pond with heavy submerged aquatic growth occurs at the center of the system. This pond is surrounded by cover types dominated by woody species. Some of the barrier beach has been developed for seasonal residences.

Colwell Ponds Marsh, Sandy Creek Marsh, Lakeview Pond Marsh, and Southwick Beach Marshes make up a large and complex flood pond system. The entire system occurs as two state-owned segments - Lakeview Wildlife Management Area and Southwick Beach State Park. It is separated from Lake Ontario by a sandy barrier beach, with dune heights of up to 50 feet. The entire flood pond system exceeds 2,400 acres. Despite state ownership of this area, virtually nothing is known of the fish species inhabiting these ponds and marshes.

There are two permanent ponds, North and South Colwell, in Colwell Ponds Marsh. South Colwell Pond provides good sportfishing and some commercial fishing. The most prominent vegetative type in the Colwell Ponds Marsh is a section of meadow emergents, about 250 acres in size.

The Sandy Creek Marsh segment is the central segment of the Lakeview Wildlife Management Area. There are two permanent ponds and a deep channel that connects through the barrier beach to the lake. There is a network of natural and artificial channels throughout the wetland system. There is also a dike present that modifies internal water levels of the wetland. Sandy and South Sandy Creeks which feed into this area are Class 1 salmonid streams. South Sandy Creek supports naturally reproducing populations of steelheads. There are also runs of chinook salmon and excellent areas for smallmouth bass spawning.

Lakeview Pond Marsh is a shallow flood pond system that exceeds 200 acres. The pond is connected to other segments of the complex through a channel to Sandy Creek. The area is heavily used for hunting and fishing.

The Southwick Beach Marshes consist of two marshes that were separated by construction activity associated with Southwick Beach State Park development. The northern marsh is connected to the southern marsh and the lake by underground seepage. Water flows freely between the southern marsh and the rest of the flood pond complex.

Little Stony Creek Marsh is separated from the lake by a barrier beach. Flow from Little Stony Creek flows through the wetland and enters the lake through Black Pond. Tree and shrub communities predominate in the wetland, but other wetland vegetation is interspersed throughout the community. The barrier beach has some cottage development and an access road on it. There has also been some dumping of fill and refuse in the wetland and if continued could have a severe impact on the integrity of the wetland.

Black Pond Wildlife Management Area is differentiated from Little Stony Creek Marsh at the narrow point where the creek enters the pond. Water flows into the lake through a connecting channel at the northern end of the pond. The channel periodically closes, causing water levels in the pond to rise above those in the lake. The pond is a good fishing area for largemouth bass, northern pike, and brown bullheads. Northern harriers nest in the area.

ElDorado Shores Refuge is owned by the Nature Conservancy.

Stony Creek is a Class 2 salmonid stream. A large embayment, open to the lake, has formed at the mouth of the creek. A wetland, Stony Creek Marsh, has developed along the floodplain of Stony Creek. Emergent vegetation dominates the wetland. Much of the surrounding upland areas are developed for seasonal residences and there has been some marginal filling.

Ray Bay Marsh is a small flood pond system which has developed along a small tributary stream that enters Lake Ontario at Ray Bay. A culvert passes beneath a road at the western end of the wetland. The culvert is subject to plugging which causes water to periodically back up in the wetland. Narrow leaved emergents predominate in the wetland.

Campbell Marsh is a streamside wetland that has developed along a minor tributary that flows into Lake Ontario at Henderson Harbor. Stream flow is sometimes reduced in late summer and fall due to sand accumulation. There has been some filling in the area which has resulted in some loss of wetland.

Sherwin Bay Marsh is a flood pond system that fronts on Sherwin Bay. The wetland is separated from the lake by a cobble barrier beach. Emergent vegetation communities extend inland along two arms of Sherwin Creek. The entire area is heavily used for recreation due to its accessibility.

Guffin Bay Marsh occurs around the periphery of a narrow inland extension of Chaumont Bay. Water in the bay is highly turbid and the density of submerged aquatic vegetation has therefore been reduced. This excessive turbidity may be a result of erosion caused by cottage construction or by an upstream quarry. Emergent vegetation is also limited due to filling operations.

Long Carry Marsh is an emergent wetland that occurs in the shallows of an inlet at the northern end of Chaumont Bay. The wetland is surrounded by roads and active agricultural land and livestock graze and water in the wetland. It also appears to be highly sensitive to changes in water levels.

Isthmus Marsh occurs in the shallow waters of western Chaumont Bay along a narrow segment of land that connects Point Peninsula to the mainland shore. Emergent and submerged aquatic vegetation predominate in the wetland. Surrounding uplands are used for livestock watering and grazing.

Point Peninsula North Marsh is a small flood pond system that occurs on Point Peninsula. It is connected to the lake only by underground seepage due to the construction of a cobble dike. Aquatic shrubs predominate in the center of the wetland with flooded and dead flooded trees behind.

Point Peninsula Marsh is a large and complex flood pond system on the western edge of Point Peninsula. A sand and cobble barrier beach separates the wetland from the lake. There is a semi-permanent connecting channel at the southern end but it closes periodically due to sand accumulation. There is a diverse mixture of emergent and woody plant species. It is significant not only due to its vegetative diversity but to its relative isolation.

Little Fox Creek Marsh is a streamside wetland, occupying the floodplain of Little Fox Creek. Flows to Lake Ontario are occasionally reduced in summer due to sand accumulation which may result in the temporary impoundment of the stream into a floodpond. Fox Creek Marsh is quite close to Little Fox Marsh and is very similar. Its outlet is less subject to closure but both systems are dominated by emergent vegetation. Both areas are also somewhat isolated.

Mud Creek (also known as Kent Creek) enters the lake through a long, narrow bay. There are two distinct segments of wetland, separated by a road and bridge. The wetland area on the lakeside of the road is extensively filled and developed while upstream from the road there remains an extensive streamside wetland.

Mud Bay Marsh is a small flood pond complex that, despite its proximity to Mud Creek, is not extensively developed. There are two small sections of wetland, each of which is separated from the lake by a cobble barrier beach.

Wilson Bay Marsh is a large and significant shrub-dominated wetland. It is a flood pond system located behind a barrier beach at the end of Wilson Bay.

Wilson Point and Fuller Bay Marshes are small flood pond systems. They are separated from the lake by cobble beaches but are hydrologically connected to it by underground seepage. There is a small open water area with submerged and floating vegetation in Fuller Bay.

Summary

It has been our intent, through this planning aid letter, to provide a description of the existing natural resources of the Lake Ontario shoreline. This letter has been prepared by using available and accessible information which, for the most part, is very limited in scope and does not adequately describe the resources present. We have coordinated the preparation of this document with the New York State Department of Environmental Conservation (NYSDEC). However, input from NYSDEC has been minimal due to the general lack of information on the natural resources of this area. Consequently, any information found in this document should be used and/or interpreted very cautiously and viewed as only the beginning of an effort to increase our knowledge of the Lake Ontario shoreline.

Sincerely yours,

Paul P. Hamilton
Field Supervisor

APPENDIX D

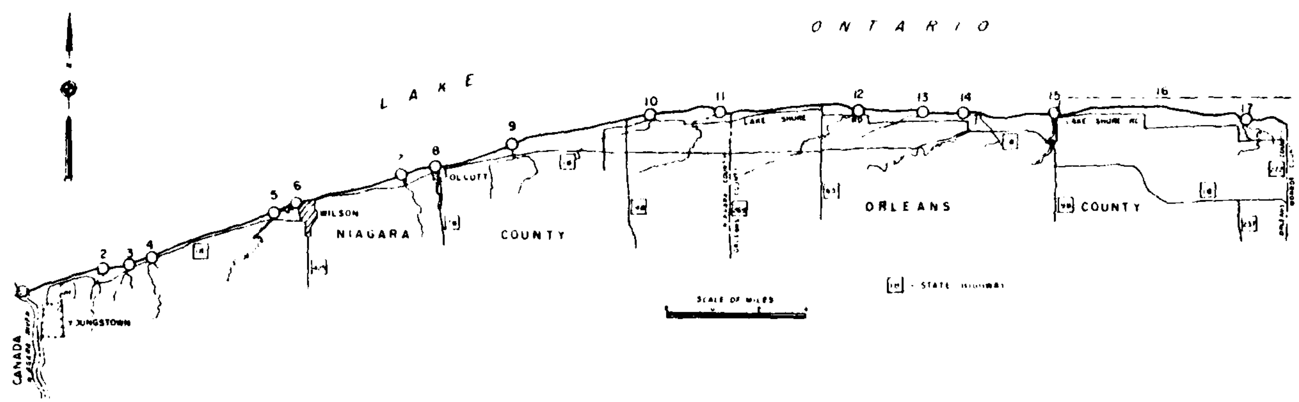
SIGNIFICANT ENVIRONMENTAL AREAS

LAKE ONTARIO SHORELINE PROTECTION STUDY

APPENDIX D

SIGNIFICANT ENVIRONMENTAL AREAS

Based upon a review of existing literature and letter or telephone communication with Federal or State agencies having an interest in natural resources, a number of significant environmental areas were identified along the United States Shoreline of Lake Ontario. Figures D-1 through D-5 show approximate locations of 211 of these areas. Each significant area described in Table D-1 is keyed to a number on one of the Figures provided. Additionally, reference materials reviewed or agencies contacted are included in an accompanying bibliography.

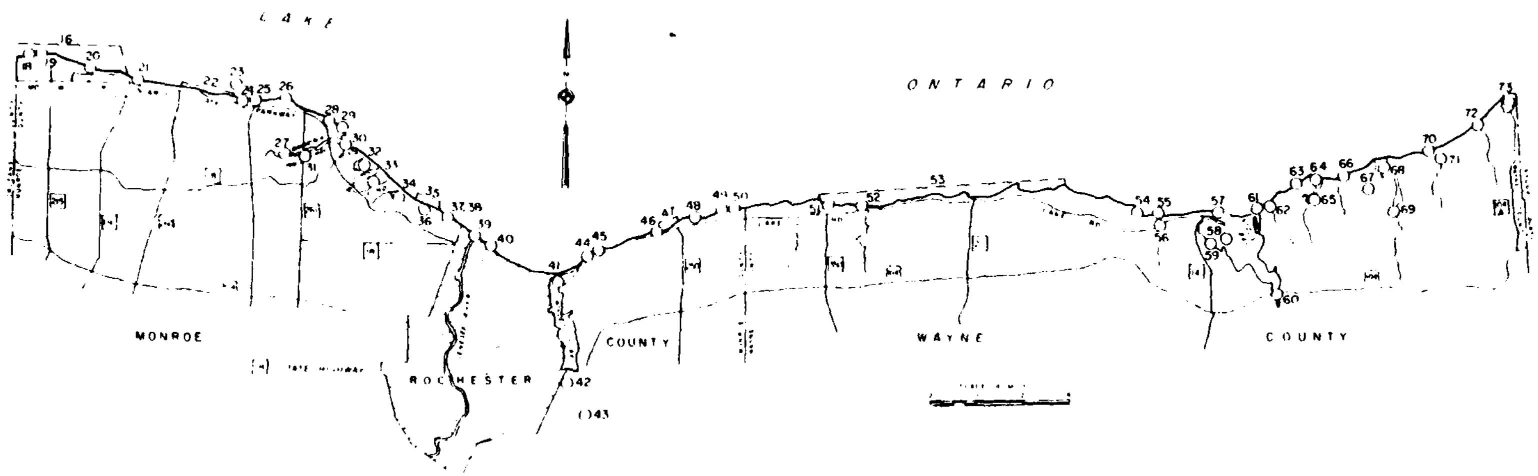


LAKE ONTARIO
SHORELINE PROTECTION STUDY

SIGNIFICANT ENVIRONMENTAL AREAS

U.S ARMY ENGINEER DISTRICT BUFFALO

FIGURE D-1

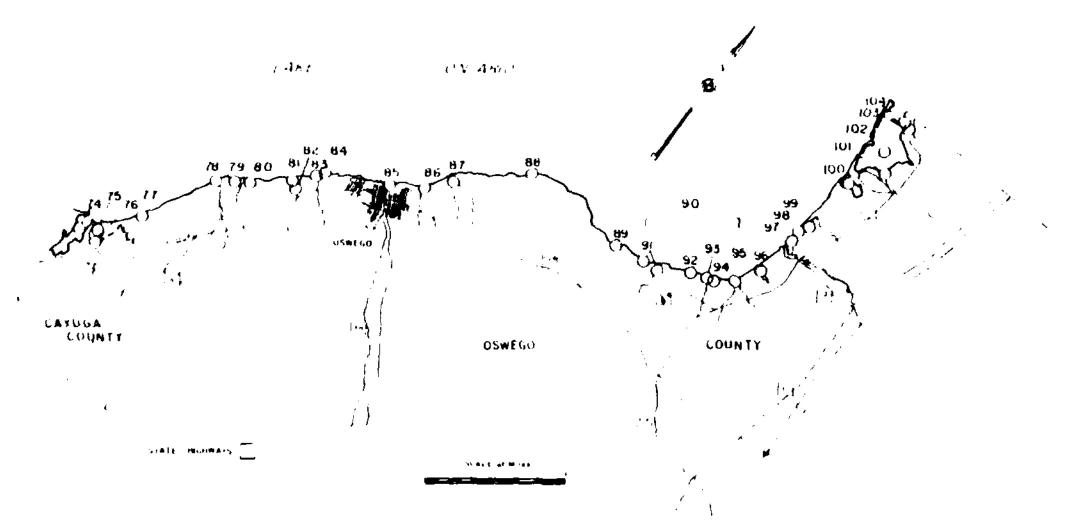


LAKE ONTARIO
SHORELINE PROTECTION STUDY

SIGNIFICANT ENVIRONMENTAL AREAS

U.S. ARMY ENGINEER DISTRICT BUFFALO

FIGURE D-2



LAKE ONTARIO
SHORELINE PROTECTION STUDY

SIGNIFICANT
ENVIRONMENTAL AREAS

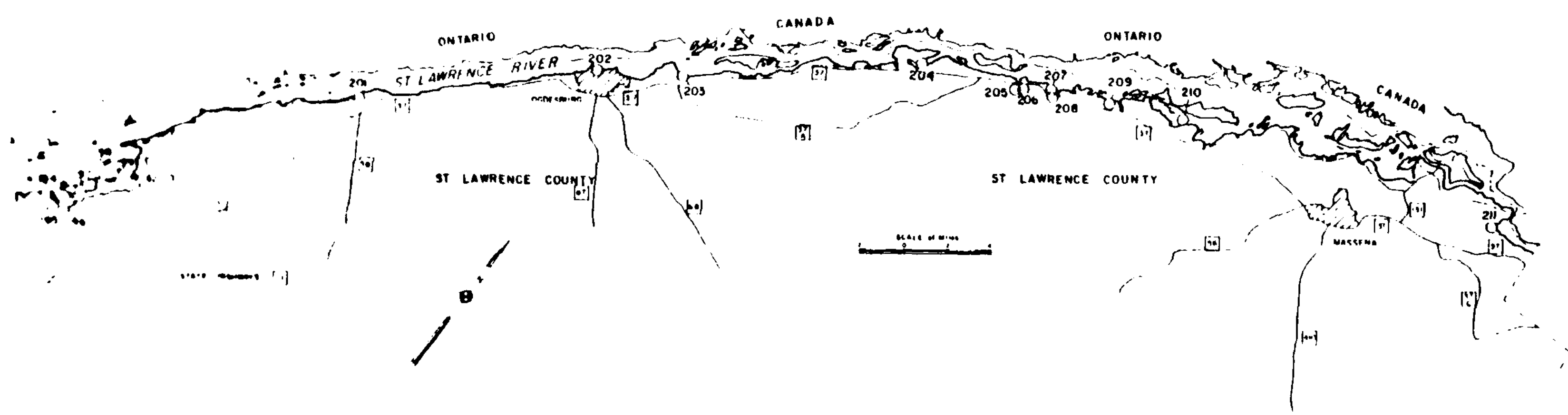
U.S. ARMY ENGINEER DISTRICT BUFFALO

FIGURE D-3

LAKE ONTARIO
SHORELINE PROTECTION STUDY

SIGNIFICANT
ENVIRONMENTAL AREAS

U.S ARMY ENGINEER DISTRICT BUFFALO



LAKE ONTARIO
SHORELINE PROTECTION STUDY

SIGNIFICANT ENVIRONMENTAL AREAS

U S ARMY ENGINEER DISTRICT BUFFALO

FIGURE D-5

Table D1 - Coastal Zone Areas of Significant Environmental Concern

Location Number	Area	Reference
1	Niagara Bar. Fish spawning area off the mouth of the Niagara River and a "hot spot" for salmon and trout.	25, 30, 43
2	NYSDEC identified protected wetland (SM-FN-1) along Fourmile Creek. Some spawning of warm-water fish species; area has value as waterbird habitat. Spring and fall salmon runs in the creek.	7, 12, 21, 25, 27, 43
3	Harrison Grove, a duck wintering area.	26
4	NYSDEC identified protected wetland (SM-2) along Sixmile Creek. Some spawning of warm-water fish species; fall salmonid run in creek.	7, 21, 25, 27, 43
5	Twelvemile Creek. Major fisheries resource stream. Fair trout and salmon migration in spring and fall; chinook and coho salmonid spawning; smallmouth bass, walleye, and northern pike spawning; important wetland associated with the creek.	1, 21, 25, 27, 43
6	Tuscarora Bay and Wilson Harbor. Angler "hot spot" during fall brown trout migration; other fish species found here are smallmouth bass, northern pike, coho salmon, rainbow and brown trout, lake trout, chinook salmon; considered to be a major fish spawning area. The bay is considered to have high scenic value; includes NYSDEC protected wetland. Wilson Harbor is a valuable smallboat harbor (Federally maintained).	1, 7, 14, 17, 25, 27, 30, 43, 44
7	Hopkins Creek. NYSDEC identified protected wetland; value to waterfowl and waterbirds.	7, 25
8	Eighteenmile Creek. Major fisheries resource stream (first 2 miles). Contains a NYSDEC protected wetland approximately 60-70 acres in size upstream of the Route 18 bridge. Lower 2 miles of the creek from its mouth to Burt Dam is known to have exceptional coho and chinook salmon and rainbow and brown trout migrations during spring and fall months; the creek also contains northern pike and bowfin and is considered to be an important smallmouth bass spawning area. Olcott Harbor is considered to be a potential marine recreation area. Marshes along creek have value to furbearers and waterfowl and they utilize wetlands during breeding season.	1, 7, 12, 14, 17, 18, 25, 27, 30, 38, 43, 44

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
9	Key Creek. In high water years there are spring steelhead runs; good warm-water fish habitat and northern pike spawning.	27, 43
10	Fish Creek. Minor salmonid movements; warmwater fish spawning habitat.	27, 43
11	Golden Hill Creek. Waterfowl and waterbird area, furbearer habitat, wetlands, other value to fish.	25, 43
12	Marsh Creek. Seasonal salmonid runs.	21, 25, 43
13	The Marsh. Duck wintering area.	26
14	Johnson Creek. Designated by NYSDEC as a major resource stream; supports a variety of fish species, including coho, chinook, large and smallmouth bass, northern pike; seasonal salmonid runs; spring white sucker runs.	1, 7, 17, 21, 25, 27, 39, 43, 44
15	Oak Orchard Creek - Major fisheries stream; seasonal salmonid runs; brown, rainbow, and lake trout and coho salmon fishery; warmwater fish species also present; spawning and nursery stream for smallmouth bass.	1, 14, 17, 21, 25, 30, 43, 44
16	Vicinity of Point Breeze to Onteo Beach. Important littoral zone; goose concentration area. Several relatively rare shorebirds use this area.	1, 25, 27, 43
17	Bald Eagle Creek and Wetland. Potential area of concern with regard to low flows; good warmwater fishery.	35
18	Point at Hamlin Beach State Park (approximate). Bank swallow nesting area; duck wintering area in vicinity of beach shoreline; concentrations of brown trout from late September to early November. Offshore concentrations of salmonids in mid-summer.	5, 13, 25, 26, 30, 41
19	Devils Nose. Highest point on south shore of Lake Ontario; waterfowl and geologic value.	4, 5, 8, 13, 25
20	Yanty Marsh. Significant wetland for puddle ducks and geese.	25, 27, 43

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
21	Sandy Creek. High value sport fishery; smallmouth bass spawning. Sandy Harbor Beach. Excellent fall fishery for coho, chinook salmon, and brown trout.	1, 8, 21, 25, 27, 43
22	Littoral area between Shore Acres and Wautoma Beach. Area used by migrating geese.	27, 43
23	Wautoma Shoal (offshore). "Hot spot" for salmonids in spring and fall as well as for perch and bass year-round.	41
24	Huffer Marsh. (Brush Creek enters from the west). Significant wetland; wildlife management area.	1
25	Unique wildlife habitat (general location).	8, 25
26	Lighthouse Beach (unique land formation).	8
27	West Creek. Seasonal salmonid runs; fishing is intense.	21
28	Rose's Marsh. Provides excellent habitat for many puddle ducks, shorebirds, passerine birds and furbearers. The outstanding feature of this area is the number of unusual (in western New York) species it supports such as cattle egret, great egret, snowy egret, little blue herons and yellow-crowned night herons. Black ducks and wood ducks nest in the upper portions of this wetland. Good migration habitat for flycatchers and spring warblers.	43
29	Hicks Point (Manitou Beach). Littoral area has value to waterfowl and shorebirds.	8, 25, 43
30	Braddock Bay (Tributary Buttonwood Creek) and associated marshes. Significant wetland habitat. Good potential area for warmwater fish spawning. Spring and summer fishing for northern pike, largemouth bass, bullhead, and white perch. Hawk migration observation area; eagles sighted in this vicinity.	1, 5, 8, 13, 14, 17, 20, 21, 25, 26, 27, 30, 41, 42, 43, 44
31	Salmon Creek (enters into Braddock Bay). Seasonal salmonid runs and warm-water fish runs. Fishing use is intense.	1, 20, 21, 25, 41, 43

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
32	Cranberry Pond and associated marshes. Waterfowl nesting; important feeding and spawning area for warmwater fish.	1, 25, 27, 43
33	Long Pond and associated marshes (Northrup Creek tributary of Long Pond). Waterfowl nesting; important feeding and spawning area for warmwater fish especially smallmouth bass.	27, 43
34	Buck Pond and associated marshes. Value to furbearers and waterfowl.	1, 25, 26, 27, 43
35	Island Cottage, Crescent and Grandview Beaches. Significant wetland area with furbearer habitat.	8, 25, 26
36	Round Pond. Wetland; some warmwater fish species.	1, 25, 26, 27, 43
37	Area along shore in vicinity of Beach Avenue near juncture of Slater Creek and Lake Ontario. Heavily used area for sport fishing year-round.	8, 25
38	General vicinity near the Russel Electric Power Generating Station (spawning area used by alewives, spottail shiners, rainbow smelt, carp, smallmouth bass.)	20, 25, 41
39	Genesee River. High value for northern pike, some spawning; associated wetlands; location of Port of Rochester; spring and fall salmonid runs.	1, 21, 25, 27, 41, 43
40	General location of unique wildlife habitat.	8, 25
41	Irondequoit Bay. Considered to be environmentally important and scenic; potential harbor-of-refuge. High value associated wetlands; some warmwater fish spawning. The bay has historically been a smallmouth bass spawning area; year-round fishing. Causeway and bridge across the mouth of the bay are a favorite shore fishing area for brown trout, steelhead, lake trout and occasionally coho salmon.	1, 8, 14, 21, 25, 26, 27, 30, 39, 41, 43
42	Irondequoit Bay marsh at south end of the bay. Considered to be environmentally important and scenic. High value wetlands; some spawning.	1, 21, 25

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
43	Irondequoit Creek (enters into Irondequoit Bay Marsh). One of the best steelhead streams in the Great Lakes.	1, 25, 30
44	Prime forest land.	8
45	Unnamed Stream. This stream has natural reproduction of rainbow trout.	43
46	Mill Creek. Potential area of concern with regard to low flows, good warmwater fishery.	35
47	Vicinity of Oklahoma Beach to Ninemile Point - Important littoral zone, also Fourmile Creek at Ninemile Point has migrations of lake-run rainbow and brown trout.	1, 43
48	Prime forest land (approximate location).	8
49	Prime forest land (approximate location).	8
50	Prime forest land (approximate location).	8
51	General vicinity of Ginna Power Generating Site. Spawning area for smelt and spottail shiners. Offshore trout and salmon fishing. Inshore brown and lake trout and steelhead. Waterfowl concentrate in the warm water discharge.	20, 25, 30, 43
52	Bear Creek. Documented rainbow trout spawning.	37
53	Vicinity of Smoky Point to Bootleggers Point. Important littoral zone; used by geese and ducks; loons and grebes winter here; concentrations of red-breasted mergansers, loons, and gebes in the spring. The warm water discharge at the Ginna power plant west of Pultneyville attracts heavy concentrations of brown and lake trout and steelhead.	1, 25, 27, 30, 43
54	Sprong Bluff. Vantage point for viewing hawk migrations.	9
55	Approximate location of bank swallow colony and rare stand of American chestnut trees.	9, 25

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
56	Maxwell Bay. At its mouth, Salmon Creek forms a 27-acre embayment, called Maxwell Bay, which is designated by NYSDEC as a significant coastal-related fish and wildlife habitat; trout and salmon spawning area; smallmouth bass spawning in Salmon Creek. Bank swallow colonies and American chstnut trees near creek.	1, 9, 14, 17, 25, 27, 30, 39, 43, 44
57	Sodus Point. One of the few sandy beaches in the area and Sodus Point lighthouse is located here (listed in National Register of Historic Places.)	9, 25, 44
58	Sodus Bay, barrier sandbar and associated wetlands. Unique geologic features and recreation area. High value Northern pike area; Fall salmon-trout fishery. Unusual plant species (Lotus beds) identified in bay area.	1, 9, 14, 21, 20, 25, 27, 30, 39, 42, 43, 44
59	South Shore. Important wetland and spawning areas.	9, 25
60	Sodus Creek (enters Sodus Bay at south end of bay.) Spawning area for the sea lamprey; stocked with coho-chinook salmon.	1, 20, 25, 27
61	Lake Bluff. Significnat woodlands and wildlife area.	9, 25
62	Root Swamp. Pileated woodpecker and red-bellied woodpecker habitat; wooded wetland and unique geological features. State Wildlife Management area.	1, 9, 25, 27, 43
63	Chimney Bluffs. Unique geological feature; scenic view.	5, 9, 13, 14
64	East Bay. Wetlands; barrier bar; redhead and canvasback duck refuge; high value northern pike area; associated park; wintering area for redhead and canvasback ducks.	1, 9, 14, 21, 25, 27, 30, 42, 43
65	Mudge Creek. Some brook trout spawning.	21, 25
66	Brush Marsh. Significant wetland.	9, 43
67	Beaver Creek. Enters into west end of Port Bay; the creek is also in the general vicinity of Lake Shore marshes wildlife refuge management area.	1, 43

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
68	Port Bay. Barrier bar and associated wetlands. Unique geologic features; high value northern pike area; recreational development area; smallmouth bass spawning in bay.	1, 9, 14, 21, 25, 27, 30, 43
69	Wolcott Creek (Enters Port Bay at south end of Bay). Significant wetland with tributaries; designated as a Preservation Area by Wayne County Planning Board.	1, 25, 43
70	Red Creek. Associated wetlands; unique geologic feature; contains an associated NYSDEC managed area; provides some fish spawning habitat.	1, 9, 21, 27, 43
71	Area of value for fish and a wetland.	25
72	Black Creek. Extensive marsh and bog along its shoreline; wood duck habitat.	1, 9, 25, 27, 43
73	Blind Sodus Bay. Barrier bay; bay is a major walleye pike spawning area and fishery; recreation development area.	1, 9, 14, 25, 27, 43
74	Litle Sodus Bay. Excellent area for smelt and smallmouth bass; salmonid spawning area; high value warmwater sport fishery; good northern pike-largemouth bass area. Value for birds during migrations.	21, 25, 27, 30, 42, 43
75	The Pond (Sterling Creek Pond). Some chinook salmon runs; high spawning value area for bull-head, smelt, and other fish species.	21, 25, 39, 40
76	Sterling Creek. Some chinook salmon runs; high value area for bullhead and smelt; excellent production fo steelhead.	21, 25, 27
77	Juniper Pond Area. Potential nesting and release site for Bald Eagles.	25, 26
78	Ninemile Creek. Spawning and nursery area for warmwater fish; salmonid runs.	1, 25, 27
79	Eightmile Creek. Spawning and nursery areas for warmwater fish; salmonid runs.	1, 27

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
80	Health Camp Marsh. Wetlands and prime breeding habitat for wood and black ducks, mallards, red-bellied woodpeckers and barred owls.	25, 39
81	Snake Swamp. Significant wetlands, waterfowl, mammal, and marshbird habitat and is probably utilized by various fish species as spawning and nursery area.	1, 25, 26, 27, 39
82	Snake Creek (enters Snake Swamp). Significant wetland area (Ramona Beach Marsh).	1, 25, 26, 27, 39
83	Rice Creek. Potential area of concern with regard to low flows; largemouth bass are utilizing this area (marsh) for spawning and/or nursery area.	35, 39
84	Burt Point area. Special interest point.	15
85	Oswego River. Salmonid fishery in the harbor, and spring salmonid runs into the river. This area is also a smelt spawning area. Smelt and steelhead fishry well established. This is an important wintering area for waterfowl and waterbirds and also the location of Port Oswego. Oswego Harbor is a "hot spot" for brown trout in the spring; lake and brown trout fishing is excellent just offshore in mid-summer. The area is also known for spring walleye and white perch and smallmouth bass.	1, 14, 15, 21, 30, 40
86	Wine Creek. Wetland area.	25, 27
87	Teal Marsh. "Showy Lady Slipper" habitat; breeding habitat for American bittern and potential for woodduck breeding.	15, 27, 38
88	Duck wintering area (general location).	26
89	Catfish Creek. Contains smelt, largemouth bass, northern pike; associated wetland marsh; spawning runs of warm-water fish and salmon-trout occur.	15, 21, 25, 27, 39, 40
90	Mexico Bay. Coho salmon and Steelhead trout are found in the Bay and Ninemile Point areas. Important for avian species and fish.	29, 42

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
91	Butterfly Creek, Swamp, and Marsh. Excellent smelt fishery; hemlock-dune complexes in the wetland, waterbird breeding habitat, potential habitat for eagles and hawks. Coopers hawk nest with fledglings was reported in 1976 here. Coopers hawk is on the Audubons "Red List."	1, 21, 25,27, 39
92	Little Salmon River. Fall spawning run of Chinook salmon. Fishery for northern pike, largemouth bass bullhead, and panfish. Spring and fall smallmouth bass fishing. Steelhead fishery present. Good spring and fall trout fishing.	1, 25, 29, 30, 39, 40
93	Sage Creek. Contains smallmouth bass, smelt, and northern pike; associated marsh present.	21, 25, 27, 39
94	Derby Hill Sanctuary. Excellent birding area - especially for hawk migration observation (March-May).	15, 25, 26, 27
95	Snake Creek and Ramona Beach Marsh. Furbearer, waterfowl, and black terns are nesting in this wetland.	25, 39
96	Grindstone Creek. Class I salmonid stream, warmwater fish spawning and nursery stream. Contains smelt, pike, bullheads, salmon, and brown trout. Fall Chinook salmon spawning habitat. Good steelhead and trout fishing area. There is an associated wetland where osprey have been observed.	21, 26, ?7, 30, 39, 40
97	Salmon River. Class I salmonid stream. Breeding area for the Snowy Egret, Least Bittern, Glossy Ibis. Port Ontario area. Warmwater fish habitat. Rich diversity of fish species-both warm and cold water; important associated wetlands; northern pike habitat; fall chinook and coho salmon spawning habitat. Famous for salmon and steelhead fishing. The Salmon River estuary is popular for northern pike, largemouth bass, smallmouth bass, bulkhead, and white perch. The river mouth is an early spring smelt-dipping "hot spot."	1, 14, 20, 25, 27, 29, 30, 39, 40
98	Deer Creek Dunes. Among the highest dunes along the Oswego coastal zone.	15, 25, 26, 27

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
99	Deer Creek and Marsh. Breeding ground for many bird species; important wetland. Very productive and sensitive area; northern pike spawning habitat.	1, 5, 14, 20, 25, 26, 27, 29, 39, 40
100	South Pond. Important warmwater fishing area. Bog area near southeast end contains unique plants. Hawk breeding area.	1, 14, 19, 25, 26, 27, 30, 39
101	Little Sandy Creek. Good steelhead fishery; smallmouth bass spawning; fall coho salmon spawning runs.	24, 29, 39
102	North Pond. Important warmwater fishing area; northern pike, smallmouth and largemouth bass habitat; excellent winter perch fishing. Principle spawning area for yellow perch in Mexico Bay.	1, 14, 19, 25, 26, 27, 30, 39
103	Lindsey Creek. Fall run of steelhead.	40
104	Skinner Creek (enters North Pond). Chinook and coho salmon fall spawning runs.	29, 40
105	Cranberry Pond Marsh Flood Pond. Important wetland wildlife habitat with excellent breeding habitat for black ducks, mallards, teals and wood ducks during high water levels.	3, 25, 27, 39
106	Colwell Ponds Marsh. Part of a large complex pond system. Brown bullhead habitat.	6, 25, 29
107	Lake Ontario dunes. Unique vegetation and wildlife habitat; State Lakeview Wildlife Management area.	3, 25
108	Sandy Creek Marsh. Central segment of the Lakeview Wildlife Management area. Brown bullhead habitat. Includes North and South Sandy Creeks.	6, 25, 27, 29, 36, 39, 40
109	Lakeview Pond Marsh. Flood pond exceeding 200 acres. Important for migrating birds.	6, 25, 26, 27, 39, 42
	NOTE: Numbers 105 through 114 are potential prime habitat for piping plover.	28

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
110	Southwick Beach Marshes. Important wetland.	6, 25
	NOTE: Areas indicated by map symbol 89, 91, 97-101, and 106-110, in the vicinity of the Lake Ontario coastline, are within the Eastern Lake Ontario Dune/Bay/Wetland complex - considered to be part of a large area of unique, exceptional, valuable, natural resource. Areas indicated by map symbols 104, 106-108 make up a complex flood pond system.	
111	Lake Ontario dunes. Unique vegetation and wildlife habitat.	3, 25
112	Little Stony Creek and Marsh. Wetland contains both wood and herbaceous vegetation, and significant fisheries.	6, 25, 27, 36
113	Unique wildlife habitat.	3, 25, 26
114	Black Pond and Marsh. Separated from Lake Ontario by a sandbar and is dependent on Lake Ontario fluctuations. Good fishery for largemouth bass, northern pike and brown bullheads.	6, 10, 25, 26, 27, 39
115	Stony Creek and Marsh. Wetland dominated by emergent aquatic plants with value for fish.	6, 25, 36, 39, 40
116	Ray Bay Marsh Complex. Small flood pond; contains emergent aquatic plants and various fish species utilize the area for spawning and or nursery area. Potential for waterfowl breeding.	6, 25, 27, 39
117	Known deer concentrations in this locale. Significant habitat for plants and wildlife.	25, 26
118	Stony Island. Important warmwater fishing area; smallmouth bass habitat; also, lake trout fishing in spring, summer and fall.	19, 26, 29
119	Calf Island, Significant wetland.	38
120	Little Galoo Island. Geologic and scenic value; largest ring-billed gull nesting area in Great Lakes Region; breeding area for double-crested cormorants.	5, 20, 26, 40

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
121	Galoo Island. Important warmwater fishing area in vicinity of the island; smallmouth bass habitat. Island serves as a herring gull rookery.	5, 19
122	Unique habitat area (general location).	14, 25, 26
123	Henderson High Banks. Unique geological formation and wildlife habitat (consists of limestone cliffs with heights of about 75 feet.)	3, 17, 26, 40
124	Snowshoe Bay. Sport fishery area.	33
125	Approximate location of popular breakwall used by sport fishermen.	34
126	Henderson Harbor. Major area for commercial and sports fishing. Important warmwater fishing area. Northern pike habitat and fishery. Smallmouth bass fishing is famous here; also, fishery for brown trout and lake trout.	19, 29, 30, 39
127	This general location has value for fish.	26
128	Campbell Marsh. Separated from Lake Ontario by a sandbar and is dependent on Lake Ontario fluctuations. Streamside wetland. This marsh is fed by the Bedford Creek Marsh, used as spawning and or nursery area by various fish species.	36, 39
129	Gull Island. Ring-billed gull rookery.	5, 26, 41
130	General locale near Bass Island is significant as wildlife habitat.	3, 5, 26
131	Sackets Harbor. Important warmwater fishing area; Northern pike habitat; ice fishing area.	19, 29
132	Mill Creek. Stream supports significant fisheries.	36
133	Muskellunge Creek. Stream supports significant fisheries.	36
134	Black River. Important fish and wildlife habitat; the Indiana Bat occurs in the Glen Park Caves near Watertown, NY. This species is Federally protected.	3, 36, 39

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
135	Perch River Wetland and Muskellunge Bay Wetland. This area comprises the Dexter Marsh Complex. The area has unique vegetation and supports major game fish.	3, 5, 39
136	Vicinity of Sherwin Bay and Black River Bay. Important wildlife habitat.	3, 25
137	Sherwin Bay Marsh. Flood pond.	6, 27
138	Guffin Bay Marsh. Brown bullhead habitat and northern pike spawn here.	6, 29, 39
139	Vicinity of Point Peninsula. Important warmwater fishing area.	19, 39
140	Important wildlife habitat.	3, 5, 13
141	Unique vegetation area.	3
142	Point Peninsula Marsh. Large complex flood pond. Diversity of emergent and woody plant species. Area provides excellent breeding habitat for black ducks, mallards, and wood ducks.	6, 27, 39
143	Point Peninsula North Marsh. Small flood pond. Contains aquatic shrubs and dead trees in wetland.	6, 27
144	Isthmus Marsh. Emergent and submergent aquatic plant wetland and the area is capable of supporting northern pike spawning.	6, 27, 39
145	Chaumont Bay, River and Associated Inlets. Important fish and wildlife habitat; provides important sport and commercial fishing opportunities. Brown bullhead habitat; smallmouth bass habitat.	3, 17, 19, 25, 29, 36, 39, 42
146	Little Fox Creek Marsh. Streamside wetland dominated by emergent aquatic vegetation.	6, 27
147	Grenadier Island. The wetlands along this island are important resting, feeding, and nesting habitat for waterfowl.	39
148	Three-Mile Bay. Large area used by shorebirds.	42

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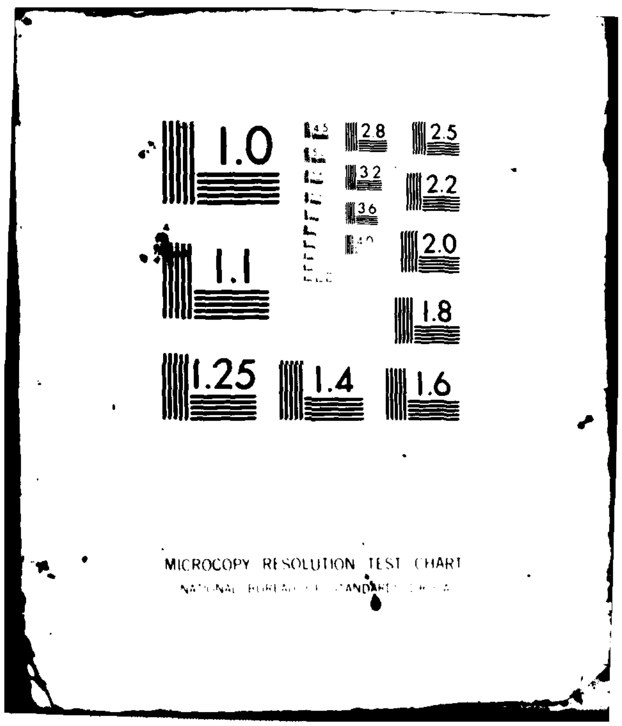
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Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
149	Long Carry Marsh. Emergent aquatic plant wetland.	6, 27
150	Fox Creek Marsh. Wetland dominated by emergent aquatic vegetation. Various sport fish use this area as spawning, nursery, or feeding area.	6, 27, 39
151	Mud Bay. Northern pike, brown bullhead, and yellow perch use this area for spawning.	29, 39
152	Mud Creek and Marsh. Streamside wetland and area supports significant wetland.	6, 25, 27, 36
153	Wilson Bay. Known local population of smallmouth bass and major production area for northern pike. Good area for nesting of various waterfowl.	29, 39
154	Wilson Bay Marsh. Unique vegetation fish and wildlife habitat.	3, 25, 27
155	Wilson Point Marsh (approximate location). Flood pond. Shrub dominated.	6
156	Fuller Bay Marsh. Flood pond.	6, 27
	NOTE: The St. Lawrence River, from Tibbett Point to Clayton (which includes Carlton Island) is excellent habitat for migrating birds.	39
157	Important wildlife habitat.	3
158	Carlton Island. This is excellent habitat for migrating birds.	39
159	Millen Bay. Numerous sport fish use this area for either spawning, nursery, or feeding area. Some species include northern pike, brown bullhead and rock bass.	39
	NOTE: The shoreline along the St. Lawrence River and its islands from Clayton to Oak Point is high quality avian habitat, including nesting and feeding areas for Bald Eagles and Ospreys.	39
160	French Creek Bay and Marsh. Northern pike habitat and supports significant fisheries. This area is a valuable breeding ground and migration stopover point for waterfowl.	6, 29, 36, 39

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location: Number	Area	Reference
161	Flynn Bay Marsh. This area is high quality spawning habitat, particularly for northern pike. The area also an important wildlife habitat.	3, 39
	NOTE: The shoreline environment of the St. Lawrence River and islands from Clayton to Oak Point is high quality avian habitat. Nesting and feeding areas are available for great blue herons, bald eagles, ospreys, common gallinules, black terns, common terns, and long-billed marsh wrens. Migrating waterfowl concentrate in the island channels for feeding and resting.	39
162	McCrae Marsh (Grindstone Is). Unique fish habitat as well as wildlife habitat. The marsh is a fish spawning area of high quality, particularly for northern pike.	3, 39
163	Eagle Wing Group Islands. Important habitat for Herring Gulls and Common Terns. The shallows and shoals of this area contain significant smallmouth bass fishery.	40
164	Delaney Marsh (Grindstone Is.) Unique fish habitat; important wildlife and high quality fish spawning area particularly Northern Pike.	3, 39
165	Picton Island. Northern limit of known Turkey Vulture breeding habitat.	40
	Note: The interior wetlands of Wellesley Island are significant habitat for marsh birds and valuable breeding grounds for waterfowl during periods of high water levels.	39
166	South Bay Marsh. High quality avian habitat and bald eagles formly nested in the area.	39
167	Murray Isle Wetland. High quality avian habitat and bald eagles formly nested in the area. Nesting and feeding areas are available for various species of birds, including the endangered bald eagle.	39

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
168	Eel Bay and Wetland Area. This is a high quality avian habitat area and bald eagles formly nested in this locale. Eel Bay has been known to contain a distinct smallmouth bass population and at one time was a major concentration area for this species. Historically, this area was a major spawning habitat for bass, channel catfish, and possibly muskellunge. These species may still use this area for spawning, nursery or feeding areas. Northern pike habitat is also present and this area is used for ice fishing.	29, 39
	NOTE: The general area of the Thousand Islands reach, in the St. Lawrence River, provides an aquatic and shoreline environment of significant value to wildlife.	5, 45
169	Flatiron Marsh. This marsh is used by migrating waterfowl for feeding and nesting.	39
170	North Flatiron Area Wetland. High quality avian habitat; bald eagles formly nested in the area.	39
171	Bradley Point Area Wetland. High quality avian habitat; bald eagles formly nested in the area.	39
172	Waterson Point Park Wetland. High quality avian habitat; bald eagles formly nested in the area.	39
173	Rift Area Marsh and Wetland. High quality avian habitat; bald eagles formly nested in the area.	39
174	Lake of Isles and Wetland. Concentration of sport fish and high quality avian habitat.	39
175	Barnett Marsh. Significant wetland area and bald eagles formly nested in the area. There is also a concentration of sport fish.	31, 39
176	Desmore Bay. High quality avian habitat; bald eagles formly nested in the area.	39
177	This is a unique vegetation area.	3

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
178	Westminster Marsh. High quality avian habitat; bald eagles formly nested in this area.	6, 39
179	Fairyland Island. High quality avian habitat; bald eagles formly nested in the area.	39
180	Deer Island Wetland. High quality avian habitat; bald eagles formly nested in the area.	39
181	Blind Bay Marsh. Marsh is important for northern pike and yellow perch. This is an excellent production area for black ducks, mallards, and teal.	6, 39
182	Mullett Creek Bay and Wetland. Supports grass pickerel, brown bullheads, yellow perch. Northern pike spawn in the wetlands upstream.	39
183	Moore Landing Marsh. This is a valuable breeding area for waterfowl and significant habitat for marsh birds during high water levels.	6, 39
184	This area has a diverse series of habitats. Rock outcroppings colonized by plant communities of herbs, shrubs, and trees.	5
185	Swan Bay Marsh. Important fish spawning area particularly for northern pike.	6, 39
186	Point Vivian Marsh. Unique vegetative area; important fish spawning area particularly for northern pike and bass.	3, 6, 39
187	Keewayden State Park. A small marsh that represents an excellent graminoid wetland.	3
188	Otter Creek. Supports significant fisheries.	36, 39
189	Carnegie Bay and Wetlands. Significant avian habitat.	39
190	Cranberry Creek (near Goose Bay). Muskellunge and northern pike spawning area. Brown bullhead habitat.	39
191	Significant Wetland Area. (approximate location)	32

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
192	Goose Bay and associated marsh (Cranberry Creek enters this bay). Important wildlife area; muskellunge and northern pike spawning area (north and south portions of the bay). Brown bullhead habitat; ice fishing area and high quality avian habitat.	5, 13, 22, 29, 39
193	Ironsides Island. One of New York State's largest heron rookeries.	20, 22
194	Unique vegetation and fish habitat area; important wildlife and avian habitat.	17, 39
195	Crooked Creek. Muskellunge spawning area at the mouth and supports other significant fisheries. This is also important avian habitat.	29, 36, 39
196	Duck Cove. Area of significant avian habitat.	39
197	Oak Island. Significant avian habitat.	39
198	Eaglewing Shoals. Nesting site for the common tern.	20
199	Chippewa Bay. Has waterfowl and fishery value. Ice fishing area.	5, 13, 26, 29, 39
200	Chippewa Creek. Unique fish habitat; wildlife area. Muskellunge spawning habitat at mouth of creek; northern pike spawning habitat and important associated wetlands.	3, 29, 32, 36, 39
201	Morristown Bay and wetland. Spawning area for large and smallmouth bass.	39
202	Oswegatchie River, Bay, and vicinity. Wildlife value; muskellunge habitat in localized areas and supports other significant fisheries.	26, 29, 36
203	Tibbits Creek and Marsh. Significant spawning, nursery and feeding habitat for various fish species including yellow perch, smallmouth bass and northern pike.	39

Table D1 - Coastal Zone Areas of Significant Environmental Concern (Cont'd)

Location Number	Area	Reference
	NOTE: Habitat along the St. Lawrence River and its islands from Waddington to Rooseveltown consists of shallow shorelines and embayments and small tributary outlets which are ideal for waterbirds and shorebirds.	
204	Whitehouse Bay. Significant fisheries for spawning, nursery, and feeding.	39
205	Sucker Brook. Northern pike spawning habitat and supports other significant fisheries.	29, 36, 39
206	Little Sucker Brook. Supports significant fisheries.	36, 39
207	Terrestrial locale near mouth of Brandy Brook. Wildlife value.	26
208	Brandy Brook. Northern pike spawning habitat and supports significant fisheries.	29, 36, 39
209	Coles Creek. Northern pike spawning habitat and supports significant fisheries. This area has breeding habitat for several species of birds.	20, 29, 36, 39
210	Wilson Hill Wildlife Refuge (Nichols Hill Island in this Refuge). This area is particularly attractive to geese and dabbling ducks.	2, 11, 39
211	Grass River. Northern pike spawning habitat.	29

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